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Safety Engg. in Mines & Occupational Health & Safety

Q. What are the statutory provisions to safeguard the workers from occupational health hazards and occupational disease?

A. Following are the statutory provisions to safeguard the workers from occupational health hazards and occupational disease

1. Initial and Periodic medical examination :-

Specific Provisions have been made under mines rules for initial medical examination of every person to be employed and periodic medical examination, once in every 5 years for persons employed in the mine.

When a person is declared medically unfit on medical examination, he may appeal to the appellate medical board for re-examination. Persons found medical unfit shall not be employed in mines.

2. Occupational health surveys: occupational health surveys may be undertaken at any mine by D.G.M.S and the mine management is required to provide all necessary facilities for survey. Any person found medically unfit to discharge his duties during the survey is entitled for medical treatment at the cost of management with full wages. If after treatment, the person is still found to be medically unfit and his unfitness is directly ascribable to his employment in mines :-

(a) he shall be provided an alternate employment
(b) if alternate employment is not available, the person shall be given disability allowance.
(c) if the person decides to leave employment, he shall be paid disability compensation.

3. Notice of disease:- When any person employed in a nine contracts any notified disease, the mine management shall send a notice to CIM.

Similarly if any medical practitioner attends on a person who is or has been employed in a mine and who is or is believed by the medical practitioner to be suffering from any notified disease, he shall send a written report to CIM stating the name and address of person and the mine and the disease from which the person is or is believed to be suffering.

4. Investigation into cause of disease:- The central govt. can appoint any lperson to investigate and inquire into and report to it on any case where a notified disease has been contracted in the mine.

5. Measures for dust control :- Reg, 123A prescribes the permissible limits of air borne dust, sampling strategies and control measures required to be adapted in mines. The airborne dust concentration shall not be more than 3 milligram per m3 of air when silica content in respirable dust is less than 5%. If silica content is more than 5%, it shall not be more than

$$\frac{15}{\%\text{ of silica}}\ \text{miligram/m3 of air}$$

6 Noise Level measurement :- Introduction of audiometry as a mandatory part of medical examination for persons seeking employment in mines and for persons engazed in operations/areas where noise level exceeds 90dB(A) has been recommended.

7 Occupational Disease Board :- Mine Management have been advised to setup occupational disease Board for formulating guidelines for referral, re-evaluation, classification of cases of Pneumoconiose's and necessary remedial action at workplace as well as rehabitation of affected person.

Q. What are the short-comings of occupational health services in Indian Mines?

A. Following are the short-comings of occupational health services in Indian mines:-

1. Lack of infrastructure facilities for conducting medical examinations in PME centers.
2. Failure to conduct initial and periodic medical examinations of person employed in mines,
3. Failure to evaluate chest radiographs as per I.L.O. classification.
4. Non- reporting of cases of notified diseases.
5. Lack of infrastructure facility for conducting dust and noise surveys.
6. Failure to conduct dust and noise surveys.
7. Lack of trained manpower in occupational health and hygiene.
8. Lack of organisational framework on occupational health and hygiene.

Q. Write a short - note on "Health and safety management system".

A. Basic Purpose of health and safety management is to create a mechanism involving all concerned at every level by which dangerous events and accidents may be prevented. Health and safety management systems include well documented modules of safety management method in form of action Procedures in all levels of management and decision making.

It may be defined as an auditable documented system that forms part of the overall management that includes organisational structure, planning activities, responsibilities, practises, produres, processes and resources for developing, implementing, achieving, reviewing and monotoring a safety and health policy of a company.

The safety management system must :-

i) define mine safety and health policy of a company
ii) contain a plan to implement the policy.
iii) State how the mine or mines intend to develop capabilities to achieve the policy
iv) Include principal hazard management plans
v) Include standard operation procedures
vi) Contain ways to measure, monitor and evaluate performance of the safety management system, correct matters that do not conform with the safety management system.
vii) Contain a plan to regularly review and continually improve the safety management system
viii) Contain a plan to review the safety management system if significant changes occur,
ix) Involve mine workers in their development and application.

Q. What are the basic ingridents of an effective safety management system of a mine?

A. Basic ingridents of an effective safety management system of a mine are :

1: Man : It includes :

- Posting of statutory manpower and training and retraining of them
- Inforcement of discipline and good industrial relation
- Introduction of safety incentive schemes
- Safety among contractual workers.
- Safety clearance of executives
- Accident inquiry and action.

2. Material : It includes

- Provision of protective appliances
- Instrumentation on safety
- Introduction of man replacing technology
- Materialisation of safety plans
- Effective communication system
- Quality assurance of safety materials

3. Organisation and management : It includes

- Effective functioning of internal safety organisation and safety committee
- Effective safety policy of organisation
- Inspection of workings
- Disaster prevention plans
- Annual action plan on safety
- Safety in transportion
- Safety clearance of workings
- Progress of u/g roof support management
- Review and monitoring of safety performance of workings
- Safety audit of workings
- Periodic safety status report
- Management of coal dust, fire, old workings
- Compliance of recommendations of safety forums/committee
- Corporate governance and thrust action by top hierarchy on safety management issues.

Q. Discuss the importance of introduction of information technology in mining for safety management system.

A. Information technology has become a major resource next only to men, money and machine to shape and operate an organisation. It can readily affect the structure of an organisation. Although, industry has recognised the importance of information technology, its application is still in a stage of infancy. A corporate information technology network will have to be developed so that it enables platform for individual and knowledge sharing.

In the mineral industry, it will have to play a major role in the areas like

- Planning and design of mines
- Exploration and production of minerals
- Safety
- Inventory control
- Capacity utilisation
- Optimisation of inputs

The following are the major thrust areas where introduction of information technology in synchronisation with management objectives will yield the tangible results in terms of production, productivity, safety and utilisation.

1. Remote control and monitoring system for accurate management information
2. Management of project implementation through computer – based software packages like Ms – project etc.
3. Introducrion of atmospheric monitoring system to improve safety standard in u/g mines.
4. Introduction of radio – communication in u/g mines in place of cable-communication (to provide communication to every part of the mine)
5. Integrated Communication network for voice and data transmission right from work sites to the corporate level.
6. Computerised maintenance technology like routine condition monitoring of the health of the equipment for better utilisation and taking corrective measures in time.
7. Quality forecasting by continuous computerised monitoring of coal samples for online ash monitoring and also removal of shale/stone from coal.
8. Introduction of integrated mine management system in large o/c mines enabling mine management to ensure optimal utilisation of system capacity.

Q. What are the various forums of worker's Participation in safety management?

A. Following are the forums of worker's Participation in safety management :-

a) statutory forums

1. **Pit safety Committee :-** under Mines Rules, a pit safety committee shall be Constituted where 100 or more persons are ordinary employed. In this committee, workmen, officials and competent persons etc. are nominated.

In large mines sectional/departmental safety committees under the main safety committee may be constituted for specific area of operation as per recommendation of 9th safety conference.

2. **Workmen's Inspectors:-** As per Mines rule, workmen's inspector shall be appointed in all mines where 500 or more persons are ordinarily employed.

As per recommendation of 9th safety conference, all mechanised mines and mines using H.E.M.M. for exploitation of minerals, where 100 or more persons employed, should appoint workmen's inspectors.

3. **Committee :-** Under section 12 of Mines Act, a committee shall be constituted by central govt. in which two persons representing the interest of workers shall also be appointed by central govt.

4. **Works Committee :-** The Industrial dispute Act requires the employer of a mine where 100 or more persons are employed to constitute a works committee in the prescribed manner consisting of the representatives of the workmen and the employer.

5. **Right of the worker's representative to inspect Form-B** register maintained under mines rules 1955 as required by Reg. 28A of CMR 1957.

6. **Right of worker's inspector or workmen to inspect the site of accident and to put his signature on sketch plan of site of accident.**

(b) Non-Statutory forms :

1. **Triparticle safety Committees** constituted at company level and consisting of representatives of DGMS, management and workmen.

2. **CIL Safety Board** headed by chairman, CIL and having CMD's, Central trade union representatives, DGMS and a representative of the ministry as its members.

3. Representation of Central Trade Union leaders in standing committee on safety.

4. Representation of workers organisation in National Conference on Safety in mines.

5. Quality Circles.

Q. What are the documents needing counter-signature of Manager ?

A. Documents needing counter-signature of manager are :

(i) Surveyor's book, list of all plans/sections/ tracings, Survey instruments, field books and other notes.

(ii) Certificates on every plan/section, prepared by or under the supervision of the surveyor.

(iii) The winding rope book and shaft installation book for every manwinding shaft except a sinking shaft.

(iv) Record of results inspections of working (both present and disused) beneath and within 45m of :
  (a) rivers, jores etc.
  (b) roads, railways.
  (c) dwellings and other structures.

(v) Record of the fortnighty tests of the brakes of the trucks, dumpers or any other vehicles used in the OCP (alongwith the engineer).

(vi) Record of written permission given by manager himself, to persons lighting fire in an o/c mine or within 15m from any entrance to a mine.

(vii) Result of analysis of dust samples.

(viii) Record of examination of protective measures, against danger from surface water, whether in use or not, for their stability.

(ix) Record of advance boreholes driven in the workings approaching within 60m of disused/abandoned workings likely to contain water or the workings in which abnormal seepage is noticed.

(x) Record of First inspection of a mine or part which is reopened.

(xi) Record of occurrence of noxious and inflammable gases in a mine or part.

(xii) Manpower distribution plan.

(xiii) Inspection report of workemn's inspectors maintained in form 'U'.

Q. What are the statutory certificates granted by the Board of Mining Examination under Mines Act ?

A. Statutory Certificates granted by the Board of Mining Examination are:

(i) Manager's Certificate of competency (Ist class & IInd class)
(ii) Surveyor's Certificate of competency
(iii) Overman's Certificate of competency
(iv) Sirdar's Certificate of competency
(v) Shot-firer's Certificate of competency
(vi) Winding Engine driver's Cerfificate (Ist class & IInd class)
(vii) Lamp checker's Certificate of competency
(viii) Gas testing Certificate of competency

Q. What are the statutory provisions in respect of the following.

A. 1. Sole responsibilities of owner

(i) Appointment of agent: The owner of the mine shall submit a statement in writing to CIM and RIM stating the name, designation and responsibility of any person authorised on act on behalf of him within 1 month of opening or reopening of a mine.

(ii) Submission of abandoned mine plan : In case of abandoned mine or discontinued working exceeding over a period of 60 day, two true copies of up-to-date plan and section shall be submitted by owner to CIM within 30 days after the abandoment or within 90 days after the discontinuous of the workings.

(iii) Cost of pan prepared by any other agency, if directed by RIM, shall be borne by owner.

(iv) Construction of protective works required by CIM either in u/g or on surface
   (a) if stability of any railway, public road. Buildings/ structures not belonging to owner has been endangered due to mining operation
   (b) if the workings has been abandoned or discontinued
   (c) where the workings of any seam are extented or get extended within any distance shorter than the statutory distance.

(v) Cost of initial and periodical medical examination borne by the owner.

(vi) Recovery of expenses of court of enquiry if court is of opinion that accidents have occurred due to negligence of mine management.

(vii) Establishment, maintenance and functioning of rescue station and rescue room.

(viii) Appointment of qualified medical practitioner on a full time or part time basis to perform the duties assigned to such officer under Mines Creche rules.

(ix) To take suitable steps for the conservation and development of the coal mine owned by him (by stowing, research work and scientific planning).

2. Duties and responsibilities of owner and agent :-

(i) They are responsible for making financial and other provisions and for taking such other steps necessary for compliance of statutory provisions.

(ii) They are responsible for proper provision, and maintenance of creche, canteen and pithead path.

3. Duties and responsibilities of owner or agent.

Owner or agent shall :

(i) Appoint a qualified manager having prescribed qualifications (may appoint himself as manger if possessing such qualification)

(ii) Not transfer, discharge or dismiss a manager unless he has been relieved by a person with requisite qualifications.

(iii) Not entrust the manager with any work which shall necessiate his frequent/prolonged absence from the mine.

(iv) Provide suitable accomodation for the Manager and Asstt. Manager within a distance of 5km from all mine openings.

(v) Except in case of an emergency, not give, otherwise, then through the manager, instructions affecting the fulfillment of his statutory duties, to a person employed in a mine, who is responsible to the manager. If any such instructions result in contravention of statutory provisions, they shall be liable for the contravention of the provision concerned.

(vi) Promptly arrange to supply the materials and appliances necessary for compliance of statutory provisions and ensuring the safety of mine and persons on receipt of a requisition from the manager.

(vii) Make over to the new owner or his agent all plans, sections and other records (statutory or otherwise). When the ownership of a mine is transferred.

(viii) Provide accurate and reliable instruments and materials for the proper carrying out of all surveys and levellings and the preparation of plans and sections.

(ix) Borne cost of photographs to be fixed on the training certificate.

(x) Provide for a suitable creche and pithead path.

(xi) Arrange for recovery of expenses in whole or part of any enquiry conducted by a committee (as directed by central govt.)

4. Notice of opening

(i) The owner, agent or manager of mine shall give notice in form I to CIM, controller (Indian Bureau of Mines) and District magistrate 30 days before commencement of any mining operation.

(ii) The form shall be accompanied by a plan showing boundaries of the mine and the shaft or openings of the mine and trijunction/revenue pillars and other prominent surface features.

(iii) In case of change of boundary, plan showing the new boundary shall be submitted within 7 days to Inspectorate of mines.

(iv) The mine management shall communicate actual date of opening to CIM and RIM forthwith.

5. Notice of abandonment or discontinuance :

(i) The owner, agent or manager shall give 40 days notice to CIM & RIM in case of intention of abandonment or discontinuance of a mine or workings for a period exceeding 60 days. Such notice shall state the reasons of abandonment or discontinuance and number of persons likely to be affected.

Forthwith notice shall be given if mine is abandoned/ discontinued before the said notice or when discontinuance extends 60 days due to unforeseen circumstances.

(ii) In case of u/g workings overwhich government property, railway, building or permanent structure not belonging to owner is situated, the mine management shall give 30 days notice to CIM and RIM of intention of abandonment / discontinuance of workings.

(iii) When a mine has been abandoned / discontinued over a period exceeding 60 days, the mine management shall within 7 days of abandondment or expiry of said period give notice in form-I to CIM, RIM and district magistrate.

(iv) The owner of mine shall submit abandoned mine plan to CIM within 30 days of abandonment or within 90 days of discontinuance.

6. Notice of accident:

(i) In case of fatal accident, seriously bodily injury and dangerous occurrence, the owner, agent or manager shall forthwith inform to RIM by telephone / express telegram / special messenger and also inform to Inspector of mines (electrical) in case of fatal / serious accident due to electricity.

(ii) Form IVA shall be submitted within 24 hours of such accidents / occurrence to District magistrate, CIM and RIM and in case of fatal accidents also to coal mines labour welfare Commissioner.

(iii) In case of fatal or serious accidents, the owner, agent or manager shall within 7 days of occurrence send to the CIM particúlar of every persons killed or injured in form IV B.

(iv) Particulars of injured persons in form IV C is to be sent within 15 days of return to duty to DGMS.

Q. Differentiate the following :

A. 1 Act Rules, Regulations and Bye-laws.

These statutes differ in the status; framing procedures, subject matters and applications. Each serves a definite purpose and therefore combining them into one will create complications.

Status : The act is principal legislation, whereas rules, regulations and bye-laws are subordinate to act. If any provisions of rule or regulations contradict the provisions of act in that case the provisions of act will prevail.

Framing procedure : An act has to be passed by the parliament whereas rules or regulation are made by the executives, although the parliament has the power to modify or annul it. Passing a law through parliament is a very lengthy procedure and therefore the act is drafted in such a manner that it does not require frequent amendments. The regulations and rules can be amended as need arises through a prescribed procedure which is comparatively much shorter and easier.

Subject matter : Act lays down the general principles, regulations and rules stipulate the details. Act specifies the subjects on which regulations and rules can be framed. In general, the regulations deals with technical matters prescribing precautions to be observed or prevention of possible dangers. The rules deals with matters related to employment of persons, their health, welfare, training, rescue etc.. Rules made generally provide for any matters not provided for under the act or regulations, provision for which is required in order to give effect to the act. Bye-laws are made for governing the use of any particular machinery or any special method of work in mine.

Applicability : The act applies to all mines whereas regulations and rules may be applicable to particular kinds of mines. For example, separate regulations have been framed for coal, metal and oil mines. Mines Rescue Rule applies to only underground mines. Pit-head bath rules have been framed for coal mines only. In contrast to these, bye-laws are framed for individual mines.

2. Agent and Deemed Agent :-

Agent : means every person whether appointed as such or not, who acting or perporting to act on behalf of owner, takes part in the management, control, supervision and direction of the mine or part thereof.

Deemed Agent : means every person who have been authorised in writing by the owner stating the name, designation, responsibilities and matter in respect of which he is authorised for a mine or group of mine to act on behalf of the owner in respect of management, control, supervision and direction of mine.

3. Owner and Nominated owner :-

Owner :- means any person who is the immediate proprietor or lessee or occupier of the mine or part thereof. It includes liquidator or receiver but does not include a person who merely receives a royalty, rent or fine from the mine or merely the proprietor of the mine subject to any lease grant or licence for the working of mine or is merely the owner of the soil and not interested in the minerals of the mine. It also includes any contractor or sub-lessee for the working of the mine but not so as exempt owner from any liability.

Nominated owner :- The person who is nominated by the management to take the responsibilities of Provisions of statute as owner is known as nominated owner.
Such nominated owner shall be person as given below :

Owner (Management)	Nominated owner (Provision)
1. Firm or other association of individual	any Partners or members
2. Company	any directors or managers
3. Government or local authority	any officers or person authorised by the govt. Or such local authority

4. Shift and Relay :-

When work of the same kind is carried out by two or more sets of persons working during different periods of the day, each set is called a relay and such period is called a shift.

5. Serious bodily, reportable and minor injuries :-

Serious bodily injury :- means any injury which involves or in all probability will involve, the permanent less of any part or section of a body, or the use of any part or section of a body, or the permanent physical incapacity or the fracture of any bone or one or more joints or bones of any phalanges of hand or foot.

Reportable injury :- means any injury other than a serious bodily injury which involves, or in all probability will involve, the enforced absence of the injured person from work for a period of 72 hours or more.

Minor Injury : Means any injury other than fatal and serious bodily unjuries which result in enforced absence from work of the persons injured for 24 hours or more.

6. Below ground and Above ground working :

Below ground :- means in a shaft or a shaft in the course of being sunk or in any excavation which extends below superjacent ground.

Above ground :- means in an o/c working or in any other place of the mine not covered by the definition of below ground.

7. Mineral and Minor mineral :-

Mineral :- means all the substances which can be obtained from the earth by mining, digging, drilling, dredging, hydraulicing, quarrying or by any other operation and includes mineral oils (which in turn includes natural gas and petroleum).

Minor mineral :- means building stones, gravel , ordinary clay, ordinary sand other than sand used for prescribed purposes, and any other mineral declared to be a minor mineral by Gazette notification.

8. Certifying surgeon and Qualified medical practitioner:

Certifying surgeons : means a qualified medical practitioners appointed by central govt. for the purpose of Mines Act within such local limits or for such mine or class or description of mines as it may be assigned to them respectively.

Qualified medical practitioner :- means a medical practitioner who possesses any recognisd medical qualification and who is enrolled on a state medical register prescribed under Indian Medical Council Act,1959.

9. Accidents and Incidents :-

Accidents	Incidents
(i)Accidents involve bodily injury or loss of life	(i)Incidents do not involve bodily injury or loss of life
(ii) Property is also involved.	(ii)Property may be involved
(iii) Accidents may be of any scale	(iii) scale is not very important
(iv)unsafe condition and unsafe act	(iv) unsafe condition and unsafe act
(v) coincidence with respect to time horizon	(v) No coincidence with time horizon.

Accidents and incidents are untoward happenings in any system. Accidents may be minor, major or disasterous depending upon the gravity of situation.

10. Industrial and Notified diseases :

Industrial disease : The disease which are contracted due to working in industry are known as industrial disease. These include pneumoconiosis, silicosis, asbestorsis, sideresis, berrylosis, nystagmas, Titenus etc.

Notified disease : These are those diseases which have been notified by the central Government in the official Gazette as diseases connected with mining operations. These include

- silicosis
- coal miner's Pneumoconiosis
- Manganese – poising nervous type
- Asbestoris
- Pneumocomsis
- Cancer of lung or the stomach or the pleara and paritoneum

Under factory Act, Noise induced hearing loss has been notified by central government as notified disease.

11. Auxiliary Fan and Booster Fan

Auxiliary Fan : Forcing or exhausting Fan used below ground wholly or mainly for ventilating one or more faces forming part of a ventilating district.

Booster Fan : a mrchanical ventilator used below ground for boosting the whole current of air passing along the intake or return airway of a mine or ventilating district .

12. Fiery seam and gassy seam

Fiery seam :- a seam in which a fire or spontaneous heating exists in the working (u/g or o/c) lying within the precints of a mine.

Gassy seam :- a coal seam or part (not o/c working) whether inflammable gas is actually detected or not in general body of air at any place in u/g workings.

Degree of gasssiness	of infammable gas	Rate of emmision of gas in m3/te of coal raised
I	not more than 0.1and	not more than 1
II	>0.1 or	> 1 but not more than 10
III		> 10

13. Ascensional and descensional ventilation

Ascensional ventilation:- implies taking air to the lowest point of a district or face and allow it to travel to higher levels to ventilate the district or face before going to return.

Descensional ventilation :- implies taking the intake air to the rise side of a district and allow it to travel to lower levels as it ventilates the working places.

14. Homotropal and Antitropal ventilation :-

Homotropal ventilation :- when the air and mineral flow in the same direction, the ventilation is known as homotropal ventilation.

Antitropal ventilation:- When the air and mineral flow in opposite directions the ventilation is said to be antitropal.

15. Banksman and onsetter :-

Banksman : a person appointed to superintend the lowering and raising of persons, tools and materials and to transmit signals at the top of a shaft or incline.

Onsetter : a person appointed to superintend the raising and lowering of persons,tools and materials and to transmit signals at any inset or shaft - bottom.

16 Competent person and official:

Competent person : in relation to any work or any machinery, plant or equipment, means a person who has attained the age of 20 years and who has been duly appointed in writing by manager as a person competent to supervise or perform that work or to supervise the operation of thatmachinery, plant or equipment and who is responsible for duties assigned to him and includes a shot-firer.

Official : a person appointed in writing by the owner, agent or manager to perform duties of supervision in a mine and includes under manager, ventilation officer, engineer, safety officer, surveyer, overman, mining sirdar, dust-incharge and sampling – incharge.

17.Working and Working place :-

working :- any excavation made or being made in a mine for search of or obtaining mineral.

Working place :- any place in a mine to which any person has lawful access.

18. Disused, discontinued and abandoned workings:

Disused/unused workings : means every place in a mine which is not required to be examined by the competent person under reg. 113 (1,3b). These are the workings not in use but acess is available.

Discontinued workings : The workings where work has been temporarily stopped with an intention to resume workings there in future and the entrances to such workings have either become inaccessible or have been made inaccessible.

Abandoned workings : The workings where work has been permanently stopped without any intention of working in future.

19.Ordinary employed, and Employed in a mine

Ordinary employed : means the average number of persons employed per day in the mine or part thereof during the preceding calender year i.e.

$$\text{ordinary employed} = \frac{\text{No. of mandays worked}}{\text{No. of working days excluding rest days and other non-working days.}}$$

Employed in a mine :- a person who works as the manager or works under appointment by owner, agent or manager or with knowledge of manager whether for wages or not in

i) any mining operation (including the concomitant operations of handling and transport of minerals upto the point of despatch and of gathering sand and transport thereof to the mine)

ii) operations/services relating to the development of the mine including construction of plant but excluding construction of buildings, roads, wells and any building work not directly connected with any existing /future mining operations

iii) operating, servicing, maintaining or repairing any part or any machinery in or about the mine.

iv) loading operations for despatch of minerals within mine premises

v) any office of the mine

vi) any welfare, health, sanitary or conservancy services required or watch and ward within a mine premises excluding residensial area or

vii) any kind of work incidental to or connected with mining operations.

Q. Who are the persons who can qualify to earn compensatory days of rest ?

A. Compensatory days of rest are required to be given to persons who are deprived off their day of rest due to :

i) Action taken under section 38 for emergency or any urgent work to be done to machinery, plant or equipment.

ii) Due to exemptions granted from the provisions of sec. 28 (weekly day of rest). Such exemptions are granted to persons noted below.

a) Who are defined as persons holding position of Supervision or management or employed in confidential capacity as per sec. 37 read with rule 46.

b) Who are exempted from the provisions of sec.28, sec.39 (power to make exempting rules) read with rule 50 & the condition mentioned in the schedule.

c) Who are exempted from sec.28 as mentioned in notification S.O. 3899 dated 26-11-1965 issued under sec. 83

Q. Give your comments on the necessity of worker's participation in safety management in mines.

A. Worker's participation in safety management of mines is necessary for the following reasons :

1) Workers suffer most if there is any lapses with regard to safety in a mine. This has been found by the analysis of the accidents which occur and also re-occur in different parts of the country. The workers should therefore be given a say in formulating the safety provisions in the mine.

2) The workers being most/worst sufferer and being present at the sites of the accidents during the occurrence of the most of the accidents. They know as to how the accidents are caused. Therefore, workers will be in a better position to suggest remedial measures. Even if they cannot suggest such remedies because of lack of technical knowledge, how they can during deliberations regarding safety management in mines bring forward subject matters for discussion which would be worth considering for formulating safety programme.

3) The workers are associated with and are considered essential partners for production and productivity. Therefore, their opinion with regards to maintenance of safety commensurate with achieving the targeted production and productivity is considered important.

This approach will also enable the management to forecast the cost of production keeping in mind the cost of production provisions necessary for achieving safety.

4) Participations of workmen even in the board of directors of the company will enable the Board of Directors to formulate safety policies and programmes keeping in mind the resource capability and other constraints of the executives such as Managers who are mainly preoccupied with production activities regarding implementation of such safety policies.

5) Worker's participation in safety management at different levels of management will enable the higher officers of the management to suitably access and appreciate the status of implementation of safety policies framed and dictated from corporate level. Worker's participation in such forums will help to eliminate attempts of more flaging the performance by executives interested in highlighting their efficiencies.

6) It is the basis of industrial democracy.

7) It creates better industrial relations, peace & cooperation.

8) It gives employees a better understanding of their role in industry.

9) It leads to increased productivity.

Q. Put up your comments on the adequacy of provisions of duties and responsibilities of owner, agents and managers under section 18 of Mines Act 1952.

A : The following are comments on the adequacy of the provisions of duties and responsibilities of owners, agents and managers :

1) It should be provided also in the act that the owner and the agent shall detail the records in a bound paged book duly signed by them, the detail the records in a bound paged book duly signed by them, the financial and other provisions provided by them for compliance of the provisions of the statute. Such records shall be signed by the owner and agent and counter signed by the manager to avoid any disputes in future.

2) Under sec. 18(4), vicarious liabilities has been placed on the O/A/M for any commission or commission of any act by any person employed in mine. Such a provision should be omitted so as to bring to book for meeting the ends of justice, the persons who are the real offender.

Although, under provision of sec. 77, O/A/M may take actions for bringing the offender to book, the procedure detailed under sec. 77 being difficult to company with, there being no enabling provision under the act to compel the real offender to be present and submit before the court before justice/trial. The law should provide that either an inspector enquiring into the contravention or any court trying the offence on a petition submitted by inspector should compel the attendance of the offender named by O/A/M and try the case accordingly.

3) Under the regulation, manager is required to maintain a diary but there is no provision either in act or in regulation that owner and agent shall at prescribed intervals examine such diaries and takes step for compliance with provision of any statute, if any omissions are observed or if any extra efforts are required to be exercised.

4) It should be provided in the act that if any instructions given by owner and agent or any person on their behalf is not confirmed in writing within three days, the manager should be free to take his own actions even if such actions are in difference with instructions given to him by owner and agent. The law should also provide that in such an event, the manager will either confirm in writing within three days that the instructions given to him are being complied with by him or they are not

being complied with in the absence of a written confirmation from the owner and agent.

5) In variance of the provisions of sec. 18(3), if carrying out of any instructions given under sub-section (2) or given otherwise than through the manager under sec 17(3), results in contravention of the provisions of any statute, the manager should not be made responsible for the lapses and he should not be proceeded against. In such a case, the person who gives such instructions should only be made responsible and may be proceeded against.

6) In case of any emergency, there is no specific duties and responsibilities mentioned in the act for owner and agent.

7) Manager should also be given financial power to manage the day to day affair because he is directly responsible for the mine.

8) There should be specific provision for qualification and age of the owner and agent as because they have to supervise or direct the mining operations.

Q. Clarify whether the following persons can be said to be employed in a mine.

A. i) Person employed in the mine canteen : Person employed in the mine canteen can be said to be employed in the mine because they must have been working under the appointment by or with the knowledge of the manager and their work is incidental to or connected with the mining operation.

ii) Persons engaged by contractor for transporting in trucks minerals from mine to railway siding : Such persons cannot be said to be employed in a mine because those persons are not working under the appointment by or with the knowledge of manager which is very essential even though the transporting the minerals is incidental to or connected with the mining operations.

iii) Vocational trainees : They are said to be employed in a mine because they must have been appointed by or with the knowledge of the manager and have been sent for training at V.T. Centre established under the M.V.T.R.

iv) Wagon loaders at a railway siding about 2 K.M. from the lease hold boundary : Wagon loaders at railway sidings about 2 K.M. from the lease hold boundary are said to be employed in a mine because :

a) they must have been working under appointment by or with the knowledge of the manager.

b) The work of wagon loading is incidental to or connected with mining operations.

c) It does not matter whether the railway siding is situated 2 K.M. away from lease hold boundary (sub-sec., ii of sec. 2)

v) Persons employed in chief Mining Engineers Office : They cannot be said to be employed in a mine because they may not working under appointment by or with the knowledge of the manager and their work may not incidental to or connected with mining operations. Moreover, Chief Mining Engineer is not covered by the definition of the manager as defined in the sub-rule f of rule 2 of mines rules.

Plan & section

Q. What is a mine plan ?

A. A mine plan is a document showing all the details of u/g workings and location of machineries and Equipments as well as surface features to a scale for a reference.

In order to establish the relative positions of different points or objects, it is necessary to make linear and directional measures, known as surveying.

The results of survey when ploted and drawn on a paper to a given scale, constituties a plan.

Q. What is a map ?

A. A map is a conventional picture of the earth's surface as seen from above. It is marked with latterings to show various places and other natural phenomena .

Q. What is scale ?

A. A scale denotes the relationship between the length of a line on a plan or map and the length of that line on the ground.

When we say that the scale of the plan is 1cm=1km, we mean that a distance of 1cm on the plan is equal to the distance of 1km on the ground.

Q. What is Representative fraction(R.F.) of the plan ?

A. It is defined as the ratio of distance on the plan and distance on the ground.

$$R.F = \frac{\text{Distance on the plan}}{\text{Distance on the ground}}$$

Both distances are measured in same units.

Q. What is a Bench mark ?

A. It is a reference point whose level is known .

Q. What is datum line ?

A. A datum line is a level line to which the vertical heights of points may measured to an assumed datums. It forms a base line to which the levels of the stations may be reffered .

Q. What is subsidiary survey ?

A. A subsidiary survey is an u/g survey made to determine the position of a face line or goaf line or some other specific features .

Q. What are isopachytes ?

A. Those are the lines drawn on a map showing equal vertical thickness of a stratum or strata.

Q. What is Mea-sea level ?

A. A mean level of the surface of water in oceans or seas between high and low tides is defined as mean sea level and is used commonly as basis of reference. The sea level, however, does not constitute a perfect spherical surface. Its equatorial diameter is being somewhat larger than the polar diameter.

Q. What is spot level ? How it is useful ?

A. Spot level is the reduced level of a particular place/spot i.e. its height from mean sea level.
Spot level is used
(i) To determine the depth of working
(ii) To know the stratum contours for planning of

pumping and haulage operation.

(iii)To know the relative position of faults etc.

(iv)To know the thickness of barrier.

(v) To know the relative position of workings with respect to water logged workings/assessing the danger of invndation.

Q. What is Magnetic Meridian ? Why Magnetic North is marked with date on mine plan ?

A. The Magnetic meridian through any point on the earth's surface is the imaginary vertical plane which passes through the magnetic north and magnetic south pole of a freely suspended magnetic needle from its centre at the point of observation.

Magnetic north changes with time and place due to declination of the magnetic meridian. So it is marked with date on mine plan.

Q. What is magnetic declination ?

A. Magnetic declination at any moment and place is the angle between the true meridian and the magnetic meridian. This declination changes with time and place.

Q. What is difference between plan and tracings ?

A. Plan :- Every plan or section or any part of it shall be prepared by or under the supervision of a surveyor on the basis of accurate surveys and levellings, field books and notes bearing definite identification number.It shall be signed and dated by the surveyor and certified by him as to be correct and countersigned and dated by the manager on every occassion when plan or section is brought up-to-date.

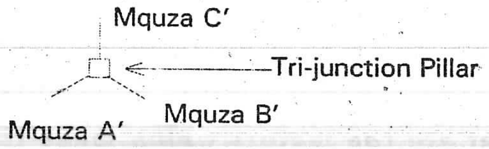
Tracings :- These are true copy of plan and should show reference number of plan from which it has been traced. It shall be signed and dated by the surveyor and certified by him as true copy of plan from which it has been traced. NOT SIGNED BY MANAGER.

Q. What is Abandoned mine plan ?

A. This is the true copy of up-to-date plan and section of the u/g workings of the mine or part and seam having average inclination more than 30° from the horizontal. It shall show the bearing and distance of at least one of the shafts or openings of the mine from a tri-junction pillar or revenue pillar or from any other prominent and permanent surface feature, the position of water-dams built u/g (with its dimension and other particulars of construction) and also the spot levels at the end of the workings.

Q. What is Tri-junction and Revenue pillar ?

A. Trijunction Pillar : It is the junction at which boundaries of three mouza meets.



Revenue pillar : These are the pillars on surface which are used for collection of revnue of land.

Q. What are the important surveys which must be done by surveyor personally ?

A. Following are the important surveys and levellings that must be personally carried out by qualified surveyors :

(i) Surface Surveys :- Establishment of triangulation base line .

(ii) Underground surveys :-

(a) Main road traverses
(b) Main road check surveys :- These should made when any point of the working of mine has advanced at a distance of 500m from the previous check survey
(c) Check surveys for reference points
(d) Check surveys for barriers against water logged workings before abandonment, and on change of ownership or on re-opening of mine etc. as per CMR 65.
(e) Correlation of u/g and surface surveys
(f) Joint surveys

(iii) Levellings :

(a) Establishment of surface and u/g bench marks .
(b) Levels of workings about to be abandoned .
(c) Subsidence levellings.

Q. How True North is determined ?

A. True North is measured by following methods :-
(a) By Gyro apparatus
(b) By G.P.S.
(c) By observing the Circumpolar star.

Q. What are the factors which make the old plans unreliable ?

A. Plans should not be relied upon fully when approaching a common boundary or old workings. The safest procedure is never to take the position of old workings for guarantee until they have actually been proved by proper survey . Such survey is however impossible if the old workings are inaccessible.

The inaccuracies of old plans include:-

(i) Decrepit condition of old plans
(ii) Shrinkage and deterioration of the material on which plans have been drawn.

(iii) Omission to show magnetic meridian or true north and to apply variation in magnetic meridian in plotting workings in periodical surveys
(iv) Omission to show full extent of the workings .
(v) Omission to correlate the workings with the surface features correctly .
(vi) Absence of spot levels at the junctions of galleries and/or of surface contours.

Q. What is national grid ? What are the main advantages in connecting mine plans to national grid ?

A. A national grid is a system of rectangular co-ordinates used by the survey of India and based upon the Traverse mercator projection (Gauss Conformal Projection).
Mercator projection is a method of map making in which latitude and longitude form a rectangular grid

Advantages in connecting mine plans to national grid :-

1. Uniformity of practise and standaridisation of method .
2. It affords ready means of correlating two or more mines and the relationship is conveniently depicted by indexed grid .
3. The square of the grid gives ready details regarding area of coal worked and unworked.
4. It is a great asset in planning and developments as better conception of positions relating to surface and underground is achieved.
5. The plans can be conveniently sectionalised, suitably indexed and establised off the master plan.

Q. What is G.P.S. ? What are the jobs performed by it ?

A. Global positioning system is a satellite based surveying equipment.The GPS sattelities are a group of 24 satellities orbiting the earth at an altitude of approximately 20,000 km. The GPS satellite, as it moves through the space transmits two radio signals continuously to the earth. On the ground, the GPS receiver(with its antens) can determine its location in terms of latitude, longitude and altitude very quickly and precisely.

Jobs performed by GPS :-

(i) Location of all surface fire features including shafts/inclines etc
(ii) Location of air monitoring, water sampling and soil sampling points for the preparation of EMP
(iii) Connection of collieries to National grid (Survey of India grid).
(iv) Topographical Survey
(v) Survey of unstable area in various coalfields requiring settlement.
(vi) Survey of degraded land and plantation areas.

Q. What is G.I.S. ? What are the jobs performed by it ?

A. Geographical information system is a digital mapping system. It is basically a high performance computer graphic and mapping system. It consists of various softwares that can analyse and produce maps relating to satellite/aerial, terrain, environmental data etc.

Jobs performed by GIS :-

(i) Preparation of important maps like land use, soil type ,vegetation, surface features mpas etc.
(ii) Maps produced for the critically unstable area of coal fields
(iii) The system can be used for any other design drawings in any discipline.

Q. What is Man Power distribution plan ?

A. This is a diagramatic representation of employment of manpower. This has to be prepared at the first week of every month after survey of employment of persons and shall be signed by the manager. A copy of this plan shall be kept in the office of the mine and one in attendence room. This plan is useful for searching of persons at the time of emergency.

Q. What is emergency plan ?

A.This is a programme of action to be followed in emergency. Manager of every belowground mine shall prepare an outline of duties and responsibilities of each mine official and some key persons like telephone operator, attendance clerk, cap lamp room Incharge etc. This shall be approved by Regional Inspector and shall be up-dated from time to time. On receiving any information of fire, explosion, inundation , major roof fall etc. the emergency plan shall come into action by the manager or other principal official available on the surface.

Q. During the up-dating of plan, the then position working is shown by dotted line with the date of last survey, why ?

A.This is done for the following reasons :-

(i) To know the position of working at any time
(ii) To estimate coal production to avoid over-reporting between two successive period .
(iii)To ascertain the name and responsibility of the then surveyor.
(iv)To pay the royalty to Govt.

Q. What is the utility of joint survey plan ?

A. It is not a statutorily compulsary requirement. However, it is helpful in providing a settled boundary between two adjacent properties, avoiding encroachment of one into others property and ensuring the maintenance of minimum barrier thickness on the boundary. .

Winding and Haulage

Q. What statory actions are required to be taken in case of over winding of a cage ?

A. Following actions are required to be taken in case of over winding of a cage :-

(i) The owner, agent or manager of a mine shall forthwith inform the R.I.M. about the occurrence by telephone or express telegram or by special messenger. A notice in form IVA, IVB and IVC shall be sent to prescribed authority as the case may be under section 23 of Mines Act and Regulation 9 of CMR.

(ii) Recapping of winding rope shall be done after every over wind as prescribed in reg. 80(6).

(iii) After recapping, the engineer or competent person shall, examine the cappel and other parts of suspension gear when the cage fully loaded with materials have made 5 trips up and down the working portion of the shaft.

(iv) Depth indicator shall be readjusted and a new marking shall be done on the rope.

(v) Automatic contrivance shall be set and tested.

(vi) Above work shall be done under the constant supervision of an engineer or a competent person.

Q.What are statutory provisions to prevent over winding of cage ?

A. Following are the statutory provisions to prevent over winding of cage:-

(i) Brakes :- Provision of one or more brakes on the drum or drum shaft.

(ii) Depth indicator – every engine shall be equipped with a reliable depth indicator showing the winding engine man the position of the cage in the ring shaft and an automatic device that will ring a bell in this engine room when the ascending cage is at a distance of not less two revolutions of the drum from top of the shaft.

(iii) Load balancing – Before lowering the loaded cage, the other cage shall be suitably loadrd for balance.

(iv) Maximum man winding speed shall not exceed the value corresponding to shaft depth.

(v) Over travel mark shall be permently made at the pit top structure.

(vi) Provision of efficient signal system to be transmitted by mechanical or electrical means.
(vii) Provision of interlocking of clutch and brake in case of clutch-drum.

(viii) Provision of automatic contrivance in every shaft exceeding 100m in depth to prevent over speeding, and over winding.

Q. What is the purpose of recapping a winding rope ? At what interval this has to be done and what is the length of the rope to be cut off ?

A. Purpose of recapping of winding rope :-
The winding rope has to suffer from maximum stress and strain at the following points :-

(i) Where the rope is held rigid because various kinetic stress and shocks are arrested and reflected.

(ii) Points in parts of which are on the pulley.

(iii) At the drum where acceleration begins.

(iv) Rope inside the drum- drum flapping slightly as the drum rotates thus causing fatigue where the rope is sharply and repeadly bent.

The purpose of recapping a winding rope are :-

(i) To remove the portions of the rope most subjected to deterioration.

(ii) To shift the parts of rope subjected to severe wear and stress.

(iii) To supply a sample which can be tested for tensile strength and its interval conditions examined.

(iv) Recapping is statutorily necessary after over wind.

(v) After all, to maintain the health of the rope :

The recapping shall be done once at least in every 6 months and after every over wind. Before recapping, 2m length of rope including capping shall be cutoff and opened and its interval condition examined. This operation shall be carried out under the supervision of engineer or other competent person and the record shall be maintained in a bound paged book.

Q. What factors should be taken into consideration for selection of winding rope ?

A. A wire rope is to be selected on the following consderation :-

1. **Watery places and corrosive atmoshphere :-** A galvanised rope should be used in such places to prevent rusting and effect of corrosive fumes.

2. **High temperature :-** Rope with fibre core should be avoided in such placrs.
3. **Stationary or running coiling rope :-** Stationary rope can be of large diameter rods or strands (guide rope in shaft)
4. **Spinning and rotating quality :-** In sinking shaft, the sinking bucket is not travelling on guides so a non-spinning rope of locked coil construction or a rope with ordinary lay should be used.
5. **Shock load :-** this should also be taken into consideration.
6. **Resistence to wear :-** In haulage and winder, ropes has to be flexible and resistant to abrasive wear.
7. **Tensile strength and safety factor :-** ropes for man winding should be of high tendile strength and high safety factor.
8. **Bending fatigue :-** Repeated bending of a wire rope over sheaves or drums causes fatigue of the wires. The rope should be flexible which is possible in a rope having large numbers of smaller diameter wires.
9. **Groove size :-** The rope should not be loose or too tight in the groove of pulley/drum.
10. **Crushing and Distortion :-** A flattened stand rope and locked rope is better able to withstand crushing than a round strand rope. The core should be of steel wire.

Q. How the winding ropes used for man winding is statutorily examined ?

A. Statutory examination of winding rope :-

1. **Weekly examination :-** Each winding rope, by pass-

ing the rope at a speed not exceeding 1m/s.

2. **Monthly examination :-** Every winding rope, by passing the rope at a speed not exceeding 0.5 m/s.

3. **Examination of recapping samples :-** Before recapping, at length including the capping of at least 2m shall be cut off and shall be opened and its interval conditions examined.

Q. What are the various inspections and examinations in a man winding shaft ?

A. Following are the various inspections and examination in a man winding shaft :-

1. shaft inspection, water garlands, shaft boundaries for pipes/cables etc- by overman or other competent persons once at least in every 7 days.

2. Winding ropes including recapping- by engineer or competent person once in 7 days or in 30 days or before recapping.

3. Suspension gear- by engieer or competent person once at least in 6 months and daily as the case may be.

4. Detaching hook- by engineer or competent person once at least in 6 months.

5. Detaching plate/bell- by engg or C.P. once at least in every 30 days.

6. Automatic contrivance and every brake- By engineer or C.P. once at least in every 7 days by raising each cage to pass the last control point above the topmost landing and once at least in every 3 months by attempting to land the descending cage at excessive speed.

7. Rope guides for cage- periodically by engineer or Competent Person.

8. Attachment of winding rope to the drum, depth indicator. Cages gates, brakes, every external part of winding apparatus- by engineeer or C.P. once at least in 24 hours.

9. External part of winding engine, guides, signalling arrangements- by engineer or C.P. nce at least in 7 days.

10 Condition of internal parts of winding engine- by engineer or C.P. once at least in 12 months.

Q. What are the statutory examination in case of sinking shaft?

A. Statutory examinations for sinking shaft are :-

1. **Signalling arrangement :-** by competent person once at least in every 24 hours.

2. **Detaching hook :-** by competent person once at least in every 7 days.

3. **Shear pin :-** by competent person after every replacement.

Q. What is discard criteria of a winding rope?

A. Discard criteria of a winding rope- A winding rope should be withdrawn from service under following circumstances :-

1. When the rope reaches the maximum statutory life or the maximum life specified by D.G.M.S.

2. When factor of safety falls below 10 or such other limit fixed by C.I.M.

3. When the outer wires have lost about 15% of their

depth as a result of deterioration.

4. When the loss in rope strength due to wear, corrosion or both is 16% of the original strength.

5. When the loss in rope strength due to fatigue, corrosion fatigue, surface embrittlement or cracked and broken wires of any kind is 10% of original strength.

6. When outer wires are becoming kinked or deformed or distorted.

7. When examination of rope has leaves any doubt as to its safety.

8. When the rope has been subjected to severe over wind or shock loading due to accident.

Q. What is the discard criteria for guide rope?

A. Guide rope should be replaced :-

1. When reduction in diameter is between 12% and 15% of the original diameter when new.

2. When reduction in diameter is 12 % if the rope is effected by corrosion of medium degree and extended to most of the portion in the shaft.

3. When the corrosion is of heavy degree.

4. When the reduction in diameter of rope is 15% any where along the length.

5. When the outer rods have lost more than one third (35%) of their depth by wear or corrosion or both or the rope no longer appears safe for use due to any defect such as broken wires etc.

Q. What is the criteria for selection of a proper guide rope?

A. Guide rope shall be either 6x1 type of construction or half-locked coil. For optimum life of guide rope and safety, the following norm is recommended.

Depth		**Diameter and construction**
(a) upto 50m	:	29mm diameter (6x1 construction)
(b) 51m – 250m	:	32 mm diameter(6x1 con struction) or 29mm diameter (half locked)
(c) 251m – 500m	:	38mm diameter (6x1 construction) or 32mm diameter(half locked coil construction
(d) above 500m	:	38 mm diameter (half locked coil construction)

Half locked coil guide ropes may be preffered in any watery shafts because they have a smooth and larger wearing surface and offer a greater resistance to corrosion as it is not so easy for water to enter the interstices between the wires. In addition , half locked guide ropes are having higher breaking load compared to stranded (6x1 construction) rope.

Q. What is the recommended tension for guide rope ?

A. The following tension is recommended in the guide ropes :-

Depth	**Tension**
1. upto 500m	1.25 Tonne per hundred metres
2. 501 – 800m	6.25 Tonne+ 0.75 Tonne per additional 100m beyond 501m

3. 801m and above	8.5 Tonne + 0.5 per additional 100m beyond 801m

Q. What are advantages of cold drawn steel wire ropes?

A. Advantages of cold drawn steel wire ropes are :-

(i) Prevents surface in brittlement
(ii) No scaling due to heating.
(iii) Prevents defects due to oxidation of heating.
(iv) Not affecting the grain structure of steel

Q. What are the safety contrivances in new generation shafts?

A. Following are the safety contrivances in new generation shafts :-

1. Use of various types of sensors in shaft for smooth control of speed, acceleration and banking of cage/ skip.

2. Ananciation panels are being installed in the winder house for fail safe information regarding cage/ skip movement.

3. Sophisticated audio-visual signalling at on setter, banks man and winding operators level for better communication.

4. Interlocking of the signal system.

5. Incorporation of thyristor for smooth control, less maintenance and greater efficiency in winding.

6. Shaft and cage telephone with intrinsically safe execution features.

(7) Efficient signal stroke fast signalling system.

(8) Proximity switches to supervise closing and opening operation of cage and raising/lowering of swinging platforms.

(9) Shaft hammer system for inspection, rope inspection.

(10) Emergency Push buttons at every station for locking of winders and to start further.

(11)Overwinding protection through modern taper guides provided in the head frame and balance rope end station.

(12) Provision for buffer beams to minimise shock resulting from any overwinding.

(13) Provision for ladder compartment to connect surface to bottom and horizon to horizon.

Q. What are the laboratery lists to be carried out for a winding rope?

A. Following tests are carried out for examination of winding rope :-

1. **Tension:-** In this testing the breaking strength of the wire is found in a testing machine and the sum of all the wire strengths gives the aggregate strength (hot the actual breaking strength) of the rope. The broken end of wire after this test will show a tension fracture.

2. **Torsion :-** In torsion testing, the two ends of a length of wire are fixed in the two holders of a machine, one holder being turned to twist the wire. This measures the ductility (toughness and freedom from brittleness) of the wire and is an excellent way of finding small faults or fatigue cracks.

3. **Reverse bending :-** In reverse bend testing, the wire is clamped in a vice fitted with specially rounded jaws and is bent backwards and forwards over these rounded jaws until it breaks.

Q. What should be the limitations of speed in a man winding shaft?

A. The following speeds should be taken as maximum rope speed for man-winding purposes :-

Depth of shaft (in metere)	**Maximum speed (in m/s)**
Upto 100	2
101 – 300	4
301-500	5.5
501-700	7
701-1000	8
1001-1500	10
Above 1500	12

Q. Define the following terms :-

(i)Snap length (ii) Factor of safety (iii) Capacity factor (iv) Critical depth (v) Sliding factor of safety (vi) Tread Pressure

A. (i) Snap length (Lo) :- It is defined as that length of the rope the weight of which is equal to the breaking load of the rope. At that length the rope breaks in its own weight at the point of suspension.

$$Lo = \frac{B}{e}$$

where B = breaking load in kgf
e = rope weight per metre length in kgf/m

(ii) **Factor of safety (F) :-** The static factor of safety is the ratio of the breaking strength of the rope to the maximum suspended static load including the weight of the rope itself.

$$\boxed{F = \frac{B}{eh + W}}$$

e = specific weight of rope (kgf/m)
H = Hoist depth (m)
W = dead weight and pay load

(iii) Capacity factor (Fc) :- It is the ratio between the breaking load of a rope and the total suspended load on that rope excluding the weight of the rope itself.

$$\boxed{Fc = \frac{B}{W}}$$

(iv)Critical depth (Lk) :- It is defined as the length of suspended rope the weight of which is 35 % of total load on the rope.

$$\boxed{Lk = 0.35\frac{W}{e}}$$

Where Lk = critical depth (length) in m

At this depth/ length, the kinetic shock on the rope is maximum. Beyond this, the effect is either constant or will diminish.

(v) Sliding factor of safety :- It has been established that the static factor of safety decreases with increase in depth and becomes minimum (F.O.S = 6) at the critical depth. The greater ability of longer ropes to absorb stresses has caused many countries to accept reduced static factor of safety with increasing depth. Deep shaft winding is practically not feasible it such concept is not established in practice. In case of metal mines, the following safety factor has been recommended in MMR :-

Depth (in m)	F.O.S.
Up to 300	10
301 – 500	9
501 – 700	8
701 – 1000	7
1001 – 1500	6
Above 1500	5

(vi) Tread pressure :- In case of friction winding, the friction tread insert is made usually of plastic type materials like rubber, polyurethene etc. Tread pressure is the specific pressure on the driving sheave. It is the crushing pressure between the ropes and friction wheel which is given by the equation.

$$\boxed{P = \frac{T1 + T2}{ndD}} \quad \text{kg f/cm}^2$$

where, n = no. of head ropes
d= rope diameter (in cm)
D = wheel diameter (in cm)
T_1, T_2 = tensile force in the head ropes on tight and slack sides of drive wheel (in kgf)

Q. What are the statutory provisions regarding travelling roadways ?

A. Following are the statutory provisions regarding travelling roadways :-

1. Duties and responsibilities of overran – To see that sufficient safety materials are available at convenient place.

2. Ventilation plan- A ventilation plan showing ventilation details including every travelling and haulage roadway shall be maintained.

3. Travelling roadways shall have :-

(a) Provision of travelling roadway separate from haulage roadway.

(b) Height not less than 1.8m

(c) Suitable steps or ladders if inclination exceeds 30° from horoizontal. In addition to this rails or ropes to be provided if inclination is more than 45° and also the platforms ar intervals not exceeding 10m measured along the slope in case inclination exceeds 60° from horizontal.

(d) Provision of cross over or cross under bridge if it has to cross a cenveyor or haulage.

4. Travelling roadway should be in the intake airway as far as possible.

5. Examination of travelling roadways – To be done by overman or competent person on weekly basis and records to be maintained in a bound paged book.

6 White washing – The roof and sides of every travelling roadways shall be kept effectively whitewashed.

6. General lighting – adequate lighting arrangement during working hours shall be provided in travelling roadways normally used by 50 or more persons in any shift. This is not mendatory, it individual lamps are provided.

Q. What precautions are required to be taken against uncontrolled movements of tubs ?

A. Precautions to be taken against uncontrolled movements of tubs :-

(i) Speed will be limited
(ii) Travelling will be prohibited.

(iii) Cross- roadways will be fenced.
(iv) All persons along the roadway shall be warned by signals independent of electric supply i.e. by mechanical means.
(v) Manholes shall be provided along such roadway
(vi) Leading tubs shall be marked with fluorescent sticks.

Q. What are the tests required to done for checking the quality of tub couplings ?

A. Tub- coupling are subjected to following tests to ensure its quality :-

(i) Breaking load
(ii) Load at which the coupling starts deforming
(iii) Hardness
(iv) Chemical composition
(v) Micro examination
(vi) Adequacy of heat treatment
(vii) N.D.T.

Q. What is discard criteria for haulage rope ?

A. Haulage rope should not be used if :-

(i) Its factor of safety becomes less than 7

(ii) Rope diameter is reduced by 15% or more due to wear, stretch or any other reason.

(iii) The total number of broken wires exceds 3 over a length of one lay of the rope or 1/10th of the total number oe wires, excluding core wires, over a length of 30 times the diameter of the rope.

(iv) It has developed any serious visible defect such as kink, permanent bend, accumulation of broken wires, broken strand and marked corrosion etc. over any length.

Q. What is difference between haulage rope and winding rope ?

A. Difference between haulage rope and winding rope :-

Haulage rope

1. No provision with respect to size of rope and size of drum
2. factor of safety not specified as per statute
3. No specified life
4. Splicing can be done.
5. Need not be a cold drawn steel wires.

Winding rope

1. Specified drum/rope ratio.
2. Statutery factor of safety shall not be less than 10
3. Specified statutery life of 3 ½ years.
4. No slicing permitted.
5. To be made of cold drawn sreel wires.

Q. What is non-destructive Testing ?

A. Non- destructive Testing (N.D.T) :-It means testing the integrity and health of equipment parts without damaging the same. Parts manufatured and those in service are subjected to non-destructive testing with a view to detect welding defects, below holes, lamiations and service induced cracks etc.

It is applied not only to the detection and location of flaws but also to the anticipation of variations or non-uniformities in properties.

Methods used are:
* Liquid Penetrant Flow detection
* Magnetic Particle Flow detection
* Ultrasonic Flow detection
* Radiography
* Acoustic emission technique

Mine workings & strata control -I

Q. What are the various permission/exemption from ACT/Regulation/Rules for opening a big O/C mine?

A. The following are the various permission/exemption from statute for opening a big O/C mine :-

1.For opening any new mine the notice under Sec.16 of Mie Act and under Reg. 3(i), shall be submitted in form I to the RIM, CIM, D. M. controller general IBM.

2. Under Reg. 3(2), when a mine has been opened, owner/Agent/Manager shall forthwith communicate the actual date of opening to CIM and RIM.

3. Under Reg. 8(2), intimation in form -I shall be given to CIM and RIM for appointment of officials.

4. Under Reg. 8(A), a statement showing names and designation of every person authorised to act on behalf of the owner in respect of management, control, supervision or direction of the mine shall be submitted to CIM and RIM.

5. Exemption shall be applied to reduce the number of UMs and ACMs under Reg. 32 and V. O. under Reg. 32A, Surveyors under reg. 35 as these are based on the production of the mine.

6. Exemption under Reg. 98 is required for bench height/bench slope.

7. Exemption/permission shall be required under Reg. 95(A) (1) from CIM for gradient of roads steeper than 1 in 14 at any place of the mine.

8. Under Reg. 105, permission to work within 45 m of any public building or permanent structure not belonging to owner is required to take from CIM.

9. Permission/exemption from Reg. 160(2) for temporary storage of explosives near the mine.

10. Exemption under Reg. 161(1) for not using contridge in open cast mines.

11. Exemption under Reg. 166 (5) (c) for blasting more than 120 holes in a shift in O. C. Mines.

12. Permission for max. charge/hole under Reg. 170 (IB).

13. Permission/exemption/approval for new blasting technique from CIM/RIM so that flying fragments from blasting can't Project beyond a distance of 10 m from the place of firing.

14. a) Notice is to be given under IER for size and type of apparatus together with such particulars which may be required by the inspector.

b) 7 days notice to inspector for new installation in the mine.

15. Exemption/permission is to be applied for any voltage other than specified under IER 118.

16. Under IER 123(7) and 9, permission is required for using flexible cable with equipment in O/C mines and length of cable more than 300 metre.

17. Of more than one type of explosives is needed in the same hole under Reg. 168 (5).

18. Primer and column charge if different, permission is required.

19. If buildings or structures within 50 metre of site of blasting, permission from CIM/RIM is required.

20. Manager should also take exception for misfire and provision of regulation which removal of streaming from shot hole.

Q. What should be the changes required in obsolute mining law for open cast mines in prest circumstances ?

A. Changes required in obsolute mining law for o/c mines-

1. Appointment of Agent (CMR 8A): The experience for the agent should be at least 20 years and qualification should be fixed for agent.

2. Appointment of U/M or Asst. Manager (CMR.32)- No. of U/M required should be as per the area so as to cover each and every workplace.

3. Appointment of Competent persons and officials (CMR36 and CMR43)-

District and duties of overman and mining sirdar should be clear and distinct.

4. Appointment of Surveyor (CMR 35)- It should be according to area not related to production.

5. Suspension and cancellation of Manager Certificate (CMR 26).

This clause should be omitted as sometimes accidents are beyond the control of the manager.

6. Types of plan (CMR 59)- O/C plans should be included in the regulation.

7. Examination for Manager's Certificate (CMR 16)- FCC and SCC should be separate for o/c mines.
8. Appointment of Manager (CMR 31(6)- Power of C.I.M. to appoint any person as a manager should be omitted.

9. Open cast working (CMR 98)- The Provisions should be according t the latest technology including dragline working.

10. Cartridges (CMR 161)- It should be omitted and use of bulk explosives should be included.

11. Drilling and charging etc. (CMR 168(s)) – This provision is irrelevant in relation to bulk explosives.

12. **Drilling and charging etc (CMR 168(16))- Exemption is required but it is not practicable. It should be in the CMR.**

13. **Transport of Explosive in Bulk (CMR 164A(1))- 30 minutes time should be omitted as it is not practicable.**

14. **Taking shelter (CMR170(1B)(a)) – The amount of explosives in a blast should be relevant with the mechanised operations in o/c mines.**

15. **Misfires (CMR 177)- Dealing of misfires in o/c mines should be included.**

16. **Section 22 (Mines Act 1952)- The inspection and serving of notice should either by C.I.M. or by a committee of experts not by DDMS.**

17. **Qualifications for Inspectors (CMR 29)- Minimum 20 years experience in mining operations with specialisation in o/c workings should be the qualification for becoming inspector.**

18. **Maintenance of machinery (CMR 182)- Preventive maintenance schedule of dragline, shovels, dumppers and other HEMMs including maintenance of their protective devices should be drafted and incorporated.**

Q. What should be height and width of benches in a mechanised o/c mine using shovel – dumpers and draglines ?

A. Height and width of benches in a mechanised o/c mine :-

1. The height of benches shall not exceed the maximum reach of the machine used for digging, excavation or removal.

In case of uniformly loose rock, the height of bench may exceed the digging height of the machine by a maximum of 3 metres if permitted by R. I. M.

2. The width of bench shall not be less than :

(i) The height of bench, or
(ii) Three times the width of dumpers, if dumpes ply on the bench, or
(iii) Twice the plan height of the excavation machines like shovels and twice the length of the body of machines like draglimes whichever is more.

Provided that where dragline is used for excavation, the width of any bench below in coal/O. B. at the finishing stage of the cut shall not be less than 3 metres.

3. Where dragline is used, before starting excavation of coal a clear space of not less than 6 metres width shall be created and maintained between between the bottom edge of the coal bench and toe of the backfill there at.

4. The width of the cut taken by the dragline in O. B. shall as for as practicable be maintained constant throughout the face so that the alignment of the coal face and the toe of the internal OB dump shall run parallel to each other.

Q. What are the factors affecting the height of bench in an o/c mine ?

A. The factors affecting the height of bench in an o/c mine are thickness of deposit, depth of deposit, capacity of drill machine, maximum digging depth of the dragline, nature of rocks, transport system, stability of rocks, slope of bench, watery condition, presence of planes of weakness like faults, weak bedding planes etc, variation of grade of ore, physical nature of ore or mineral, extent of O. B. etc.

However, if height of bench is more, there is problem of supervision and travel of loose rocks from the bank slopes.

Slope angle of bench should be either equal or less the angle of repose of bench rock. In moderately loose or friable rock, the dressing of the bench slope is necessary upto angle of repose of rock to prevent overhanging and subsequent falling of rock when the materials get loosed by the action of weathering or vibration of H.E.M.M.

Q. What are the safety and protective devices in H.E. M.M. ?

A. Safety and preventive devices in H.E.M.M. are :
(a) Hydraulic Excavator :-

(i) Manually operated dry chemical powder type portable fire extinguishers (as per recommendation of 8th safety conference, automatic fire extinguishing system has to be provided).
(ii) Seat belts
(iii) Hydraulic control lever lock
(iv) Falling object protective structure
(v) Automatic lock-Parking brake system
(vi) For operator's comfort-
Oil Suspension Seat
Air conditioners
Low noise operation (90 dBA).

(b) Dumpers:

(i) Belly guard for transmission and engine.
(ii) Drive line protector
(iii) Body position warning device
(iv) Body up position warning light
(v) Brake dirt and water shields
(vi) Engine oil and water temperature indicator
(vii) Parking light and parking brake
(viii) Fire extinguishers (manual and automatic)
(ix) Low air pressure warning device
(x) Emergency steering system
(xi) Back-up light
(xii) Back-up alarm and indicator
(xiii) Turn Signals
(xiv) Emergency brakes
(xv) Ratarder brake – overspeed protection
(xvi) Radiator fan guards
(xvii) Baffle plate between turbo charger and exhaust pipe

(c) Dozers :-

(i) Fire extinguishers
(ii) Roll over Protection system for cabin and cannopy
(iii) Gear shift lock
(iv) Hydraulic control lever lock
(v) Automatic lock parking brake system
(vi) Backup alarm
(vii) Seat belt
(viii) Transmission mechanism
(ix) For operator's comfort- oil suspension seat, Air Conditioners etc.

Q. What are the factors influencing spoil dump stability ?

A. Factors influencing spoil dump stability are :-

1. **Spoil dump geometry such as :**

(a) **Height of spoil dump :-** slope stability generally decreases with increasing height of spoil dump as the shear stresses within the spoil mass increases due to added weight and may exceed the shear strength of the spoil material.

(b) **Slope of spoil dump :-** Low slope angle minimises the adverse effects of increasing spoil height.

(c) **Zonation in spoil dump :-** The zonation of this spoil material results in different strength and density material through the spoil pile which can control this failure surface and influence the nature and extent of spoil stability

2. **Water :-** It adversely affects the dump stability by changing the material strength and influencing the pore water and seepage forces.

3. **Climate :-** The total precipitation affects the groundwater conditions and drainage through spoil dump and reduces the stability of spoil dump.

4. **Foundation of dump :-** Nature of foundation strata and its slope angle is to be found very carefully.

5. **Geotechnical Parameter :-** Shear strength of foundation materials should be greater than shear strength of material comprising soil dump.

6. **Mining equipment and mining method.**

7. **Drainage :-** It affects the ground water condition and pore water pressure and hence stability of

dump. The surface water must be prevented from entering spoil dump and the foundation with the help of proper drainage.

8. **Blasting :-** The Fragmentation of O. B. rocks affects the initial particle size of spoil material. The well graded fragment size may allow a denser packing and thereby increases density and strength of spoil material.

Q. Write short note on slope stabilisation.

A. When safety factor of a slope is found to be inadequate, it needs to be stabilised. The method for this are :-

(a) External Support
(b) Removal of water from the slope
(c) Removal of material which is likely to slip.

External support is given by retaining walls (in soil slopes) as a temporery measure, provided the wall is higher than the slope and its foundation is below the expected slip surface, such walls are practicable only in case of short slopes.

Rock-bolting with pre-tensioning and with or without shot creating is a fairly permanent measure, in rock slopes. The bolt must extend beyond the failure surface.

Dewatering of slopes also called depressurisation, reduces water- pressure components and also improves the properties of rockmass.

The third method of slope stabilisation is removal of material to form shorter benches or regrading the slope. This is adopted when support measures are not likely to be effective.

Q. What are the factors influencing slope stability in open cast mines ?

A. The rock mass behind each slope is unique. To design proper slopes for each case of rock formation, the geological data, rock strength formation, ground water data and pressure is required.

Some of the factors influencing slope stability in o/c mines are :-

(i) Geology of the place .
(ii) Hydrogeology
(iii) Rainfall
(iv) Discontinuties in rockmass and their relative orientation.
(v) Identification of unfavorable discontinuities
(vi) Shear testing of discontinuities.
(vii) Designing of Stabilisation measures to improve their peformance including :-
    (a) Additional drainage measures.
    (b) Reinforcement techniques etc.
(viii) Method of open pit excavation :-

Slopes have to be designed by qualified and competent rock-mechanics engineers after taking above mentioned factors into consideration.

Q. Define factor of safety of slope.

A. The factor of safety of a slope is defined as the ratio of the force resisting the slide (internal friction) to that causing the slide (force of gravity).

$$F = \frac{\text{Force resisting the slide}}{\text{Force causing the slide}}$$

In limiting equilibrium, the force required for sliding is exactly balanced by the force resisting the slide, and therefore, F = 1

The factor of safely of a slope can be increased by installing bolts or by water drainage

For temporary mine slopes s, F=1.3
For important haul roads, F=1.5

Q. What are various types of slope failure?

A. There are three principal types of slope failure :-

(i) Plane failure
(ii) Wedge failure
(iii) Circular failure

Plane failure occurs when a plane of discontinuity such as a bedding plane, fault etc strikes parallel to the slope face and dips into the pit at an angle greater than angle of friction.

When two discontinuities strike obliquely and intersects on the slope face, wedge type failure results.

In Soils or highly jointed soft rocks in which failure palh no longer defined, a circular failure occurs. Stepped failure is the special case of plane or wedge failures and occurs in hard blocky rocks.

Q. What is a balancing diagram ? What are the parameters needed for its preparation ?

A. A balancing diagram is the tool in the hands of the user, where an attempt is made as where and how the compact overburden in swelled form will be adjusted so that the dragline dump remains stable, the dragline is utilized to an extent of 100%, what will be dump height from coal floor, what will be the annual coal exposure and what will be the % of rehandling. In fact, it is a computer programming in which decision making process is programmed in order to make Dragline operation optimal, safe and economical.

For the preparation of Dragline balancing Diagram, a number of parameters are needed like the Dip of the coal seam, coal bench elevation, Dragline bench elevation, angle of key cut, Angle of repose, Seam height, specific gravity of coal, cut width, height of dragline bench, minimum width of key cut at bottom of Dragline bench, swell factor, Blast Swell factor, width of drill rod, design parameters of Dragline like horizontal reach, drum diameter, maximum vertical reach of dragline boom upto which it can dig and its annual productivity as well as system factor.

Q. What is system factor ?

A. For the termination of system capacity of an opencast mine, a system factor is applied, which is defined below :

System factor =

$$\frac{\text{Total annual workload of coal and OB in M. Cum.}}{\text{Cumulative sum of annual productivity of excavators.}}$$

In the project reports, the cumulative sum of the digging capacity of the shovels in terms of annual productivity will always be higher than the annual workload for coal and OB, Combined. Hence, for each project, depending upon the prevalent mining and geologival conditions, a system factor is to be applied.

Q. Define the following terms :-
(a) Struck capacity (b) Heaped Capacity (c) Fill factor (d) Swell factor (e) stripping ratio (f) Break-even stripping ratio (g) Limiting stripping ratio.

A. **(a) Struck capacity :-** It is the inner volume of a bucket, when the material level on the top of the bucket is assumed to the horizontal.

(b) Heaped capacity :- It is the inner volume of a bucket, when the material level on the top of the bucket is assumed to be in the form of convex heap. Heaped capacity varies from material to material for the same bucket as the heap pattern depends on the angle of repose of the material.

(c) Fill factor :- This is a measure of the degree or fraction of bucket filling during excavation. It indicates the void space inside the Bucket when it is filled up during excavation.

Mathematically, it is expressed as :-

$$F = \frac{\text{Inside volume of the bucket}}{\text{Volume of materials accepted by the bucket at its maximum.}}$$

It depends upon :

(i) Particle size or fragmentation size
(ii) Type of material handled
(iii) Difficulties the bucket has to face in penetrating the materials
(iv) Penetrating or crowd forces with which the bucket is forced against the material.

In general,
F= 85% for Bucket-wheel excavator
= 65 % for dragline
= 75 % for shovels
=80 % for Hydraulic shovel

(d) Swell factor :- It is defined as the ratio of volume of material measured in virgin condition and volume of loose material when excavated.

(e) Stripping ratio :- It is defined as the ratio of weight of recoverable mineral reserve in tonne to the volume of overburden in cubic metre.

$$SR = \frac{\text{Wt. Of mineral}}{\text{Volume of OB}} \quad (te/m^3)$$

It is generally expressed in the proportion of overburden to coal/mineral removed

(f) Break-even stripping ratio :- As the depth of overburden increases more amount of money is spent for removal of the overburden for exposing the mineral/coal and a time will come when mineral/coal can not be economically extracted out. The point beyond which the mineral/coal can not be economically extracted out is called the break-even stripping ratio.

It may be expressed as :

$$B.E.S.R. = \frac{(\text{Cost/te of coal by u/g method}) - (\text{Cost/te coal by o/c method})}{\text{stripping cost/m}^3 \text{ of OB by o/c method}}$$

This is generally much higher than the ordinary stripping ratio and can be increased if the price of ore/coal is increased or if the technology of mining is improved.

(g) Limiting stripping ratio :- When an underground method of mining is also economically feasible, the limiting stripping ratio is that ratio at which the cost of opencast mining equals that of underground mining.

Q. What are virgin stresses in rock ?

A. The stress in the rock prior to mining operation can be classified as :

(i) Inherent stress :- It is the stress contributed by the constituents of the rocks.

(ii) Induced stress :- Stresses which are induced in the rocks due to external causes like tectonic movements, hydration and dilation of argillaceous shales etc.

(iii) Residual stress :- stress which remains after the cause of stress has disappeared. The rocks are not perfectly elastic bodies as they cannot destress themselves completely.

(iv) Burden stress :- This is due to the weight of overlying strata.

(v) Lateral stress :- This may be caused due to organic forces or due to the inabilities of rocks to expand at depth under the action of burden stress. It acts at right angles to the burden stress.

Q. Define the following terms :-

(a) Setting load (b) Yield load (c) Load-bearing capacity (d) Early bearing Props.

A. (a) Setting load :- Setting load is defined as the reaction offered by the prop to the strata . It is imparted to a yielding prop ensuring that support is firmly in place and can resist lateral pressure due to the passage of the face machinery.

(b) Yield load :- It is that load on a prop at which the upper member begings to slide. Hydraulic props are specified by its yield load.

(c) Load bearing capacity of a prop :- It is defined as the load at which an axially loaded prop reaches its elastic limit or at which it begings to buckle.

(d) Early bearing props :- These are yielding props which accept the maximum load with a minimum yield. It reduces convergence and bed seperation

Q. What is an air blast ? What are the causes of air blast ? What steps are required to be taken to avoid it ?

A. Air blast :- This is the phenomeon(happening) of rushing out air due to major and sudden roof fall of large hanging roof. The pressure is so violent that coal tubs, machines, supports, stoppings etc. are blown out taking lot of lives and damaging the property.

The major causes of air blast are :-

(i) Caving not taking place regularly and keeping a hanging roof.
(ii) Wide exposure of roof
(iii) Unsystematic working
(iv) Method of working improper
(v) Unsystematic support system

To aviod air blast, the following steps are requiredto be taken :-

(i) Selecting proper method of mining
(ii) Proper goaf treatment
(iii) Induction of roof if roof fall is not taking place
(iv) Withdrawl of persons if indication is obtained
(v) Selection of proper support system i.e. support resistance should be sufficient
(vi) Mining sirdar should carrry a whistle to indi-

cate withdrawl of persons .

(vii) Installation of convergence recorder to predict roof fall.

Q. What is strata control ? What are the factors affecting strata control ? What are the parameters required to be studied for strata control practices in depillaring ?

A. Strata control :- To control deformation of roof by timely support to a minimum and in general caving is a part of strata control.

Factors influencing the control of strata movements

(i) Geological formation of roof beds.
(ii) Cleat of coal
(iii) Crushing of floor
(iv) Strength of floor
(vi) Width of extraction

For strata control practises in extraction of pillars, it needs intensive study of the following parameters :-

(i) Develppment of stress and strain in the pillars during depillaring.
(ii) Convergence.
(iii) Prop loads.
(iv) Effect of splitting on convergence, prop load stress in adjoining pillars.
(v) Effect of extraction on convergence, prop load and stress in adjoining pillars.
(vi) In multi-section workings, effect of mining in one section over the other .

Q. What is difference between support and reinforcement ?

A. **Support**

(i)Application of a reactive force at the face of the excavation.

(ii) Essentially provides surface restraint to the rockmass by installation of structural elements on the excavation boundary.

(iii) It includes Fill, Timber, Steel, Precast concrete, shot creates,props etc.

Reinforcement

(i)To improve the shear and tensile strength of the rockmass adjacent to u/g excavations, This esentially includes all techniques which seek to increase the strength or decrease the deformity characteristics of a rockmass.

(ii) Methods which modify the interior behavior of the rockmas by installation of structural elements within the rockmass.

(iii) It includes Grouting of bolts and cables, injection of chemical or cementations, grouts, ground freezing etc.

Q. What are the advantages and disadvantages of timber as a primary means of support ?

A. **Advantages** :-

(i)Load bearing capacvity is low but fails slowly. Hence it gives early warning of overloading.

(ii)Matches closely the requirements of non-mechanised methods of extraction with the advantage of cost/strength ratio.

(iii)Ready useability as immediate support and innate advantage as an indicator of roof movement.

(iv) It is cheaper.

Disadvantages :-

(i)Unsatisfactory permanent support as it decays with time due to moisture and fungal action.

(ii) Unsatisfactory support for freshly exposed roof as setting load is low.

(iii) Unsuitable for mechanised mining as it is not compatible with faster development in complex-geo-mining conditions.

Q. What are substitute for timber supports ? What are their advantages ?

A. Because of decrease in availability, quantity and quality and increase in cost, now substitute for timber has become very import.

Such substitutes are as follows :-

(i)Steel :- Prop, Girder, Arches, Sheets, chocks, Power Sypport, framed support, struss etc.

(ii)Bolts :- M.S. rods, cement bolts, concrete bolts, resin bolts etc.

(iii)Stitching :- Rope stitching by steel wire ropes, nylon ropes.

(iv) Cement/concrete :- Casting, lining,blocks, cheas weights.

(v) Bentonite :- special mineral material used like cement.

(vii) Brick walling, packwalling, stowing.

Advantages :-

(i) Easy in availability
(ii) Reduction in cost as compared with timber
(iii) Increase in production and safety
(iv) Uniformity in quality
(v) Flexibility
(vi) Longer life

Q. What are the advantages and disadvantages of roof-bolting ?

A. Roof bolting :-

Advantages

1. Reduction of bed seperations and roof deterioration giving increased safety and reduction of accidents due to falls of roof.

2. Improved roof control permits higher percentage of coal extraction and gives rise to increased O.M.S.

3. Lower handling and support cost.

4. Decreaed ventilation cost due to reduced resistance to air flow.

5. Increased headroom and convenience of bolts for suspension of air and water pipes, cables and signalling lines.

6. It is an active support which allows the roof to be self supported.

7. Loading points and junction remains supported at all times.

8. With U-W straps and wiremesh very bad roof condition can be effectively managed.

9. Improved strata control decreases the emission of gas into mine workings.

Disadvantages

1. It cannot be applied in all cases.
2. It gives no forewarning of the impending failure
3. Non-recoverable bolts may entail greater cost.

Q. What is the aim and mechanism of roof-bolting ?

A. The principal aim of roof bolting is to secure the immediate roof to a stronger strata above because when an excavation is made, roof layers sag from the main roof due to bed separation. The roof bolt is applied to avoid these sags.

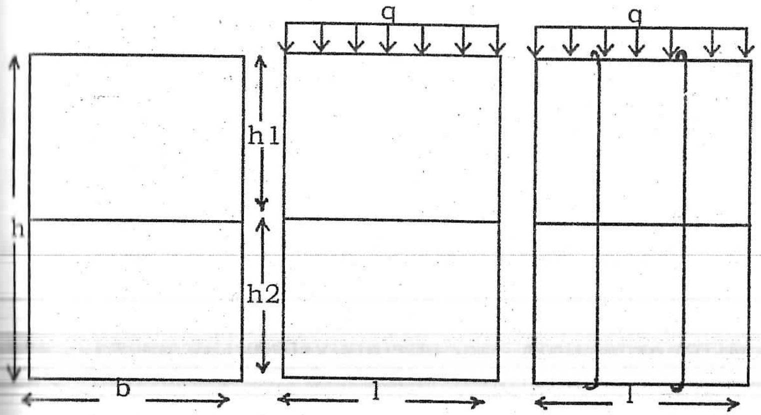
As a roadway is formed, horizontal and vertical stresses previously carried by the newly extracted strata are diverted into the roof, floor and sides. As the roadway progresses, this superimposed extra stress can build up to cause failure in the various layers of strata, depending on their mechanical properties and stresses involved. Essentially, roof bolting reinforces the strata by introducing into it a high strength reinforcing member, commonly a steel bolts. The transfer of the ground stresses into the bolt induces tension in the bolt which in turn generates confinement of the strata leading to a much stronger structural material, which in a properly designed and applied system, will provide stable working conditions. Because of the resistance to shear and the confinement of the individual strata layers, the overall effective reinforcement capacity of a full column grouted

bolt is substantially more, compared to other types of bolts like point anchor etc.

It appears from experience gained in roof bolting that unless the laminated strata contain some fairly strong measures, the possibility of successful roof bolting is limited.

Q. What is the principle of roof bolts ?

A. The roof at the entries of the coal mines acts like beams supported on both sides with layers separated from each other. The designer of the roadway supports must take weight of such separated beds (immediate roof) into consideration.



Let us consider two roof layers whose thickness are h_1 and h_2 and width b. If the span of the opening is R and the uniform load is q, there will be a maximum bending stress in the middle as follows :–

$$\sigma = \frac{0.75ql^2}{b(h_1^2 + h_2^2)} \qquad \text{(i)}$$

If these layers are tied together by means of a bolt, the bending stress s^1 in the middle o the span would be

$$\sigma^1 = \frac{0.75ql^2}{b(h_1+h_2)^2} \qquad \text{(ii)}$$

It $h_1 = h_2 = ho$, then from equation (i) and (ii), we get

$$\frac{\sigma}{\sigma^1} = 2 \quad \Rightarrow \quad \sigma^1 = \frac{\sigma}{2}$$

Therefore, by binding two layers together, bending stress can be reduced to half.
On the other hand, the tensile stress met on the roof can be carried by "steel rods " quite resistant to tensile stresses.

Q. What is shot crete ? How does it work ? What are their advantages ?

A. Shot crete is concrete shot from the hose for supporting underground openings like permanent galleries, inclines, drifts, shafts, slopes etc.

It is applied in thin layers. Since shot crete is weak in tension, it is usually reinforced to increase its ductility capacity on account of tensile cracking. The shotcrete reinforcement consists of steel fibres which is placed between the two shotcrete layers.

The basic shotcrete mix consists of cement, sand, coarse aggregates and water. The additives are added to the mix to improve the shotcrete property.

Working of shotcrete :-

Step 1:- The shotcrete is sprayed on the rock surface with high velocity usually 100m/s

Step 2 :- It consists of two phases.

Phase I :-

(i) A thin layer of cement and fine sand particles is formed which penetrates pores, cracks, joints in the rock mass and provides a foundation for further build-up of the shotcrete layer.

(ii) Normally 100% of the coarse aggregates rebound and fall on the floor at this stage.

Phase II :-

(i) As the impact of the shotcrete spray continues, the fines are squeezed into pores, cracks and joints in the rock mass.

(ii) The shot crete starts sticking on the initial thin layer of the fines with some bond strength and thus the shotcreate layer builds-up and gets compacted under continued impacts of the shotcrete spray. The rebound reduces substantially.

Advantages :-

(i) It is cheaper
(ii) It acts as a membrane in bending or tension
(iii) It prevents rock exposure to changes of moisture, effect of air and temperature etc
(iv) It controls rock mass deformation and prevents loosening of rock and mobilizes inherent strength of the rockmass for supporting.

Q. What are your suggestions to minimise the safety and health risk of the persons engazed in roof-bolting operations ?

A. Suggestions to minimise the safety and health risk of the persons engaged in roof-bolting operation are :

(i) Acquisition of the most appropriate types of machine and equipment for a given application.

(ii) Compatibility of the roof-bolting system with other operations.

(iii) The use of mechanised methods to reduce the levels of physical stress.

(iv) Safety requirements for working platforms.

(v) safe methods of access to the work place.

(vi) Development of code of practice for safe roof bolting system.

(vii) The use of protective clothing and safety aids.

(viii) Issues relating to supplies logistics.

(ix) Briefing and checking of work teams.

(x) Training requirements for supervisors.

(xi) Refresher training of roof-bolting gang.

Q. What is over-riding of pillars ? What precautions are required to be taken to prevent over riding of pillars ?

A. A strong thick stratum of massive sandstone in the roof immediately above the seam will delay the roof fall and when a sufficiently large number of pillars is extracted, the main roof will ultimately break with the build-up of pressure. The weight of the strata is transferred over the pillars on the out bye side before the roof fall takes place. If the pillars are not strong enough, they may be crushed due to such sudden heavy pressure. This phenomenon is known as overriding of pillars and results ultimately into premature collapse in the area.

When the line of extraction is from rise to dip, overriding of pillars occurs. It takes place when goaf falls behind the line of extraction. When roof falls, it overrides the pillars.

Precautions to prevent overriding the pillars:-

(i) Maintaining diagonal line of face.

(ii) Goaf edge rigidly supported to allow goaf comedown.

(iii) Face line (advance) should be from dip to rise.

(iv) V-line of face should be avoided.

(v) Front abutment pressure should not fall upon the pillar splitted.

(vi) Extraction of coal in the pillar must be completed or no stooks / ribs should be left.

(vii) If complete extraction is not possible, the remaining stoooks / ribs should be blasted down on retract.

(viii) No support left inside the goaf .

(ix) When roof refuses to collapse after withdrawal of of supports, means should be taken to induce fall inside the goaf.

Q. What precautions should be taken while pillar extraction is taken by caving method in two sections of a seam or in two seams which are contiguous to each other ?

A. Following precaution shall be taken during extraction of pillars by caving method in two sections of a seam or in two seams which are contiguous to each other :-

1. The extraction of pillars i.e. drivage of split gallery and the extraction of slices in two sections/ seams shall be done simultaneously such that the line of extraction in both the section/seams are superimposed.

2. The workings in each of the sections/seams shall be under the supervision of a separate Mining Sirdar.

3. The working of both the sections/seams will be placed under the charge of same overman for better co-ordination of the workings.

4. The overman shall be furnished with an offset plan showing the workings in both the section/seam in different colors showing there on the sequence of extraction of pillars.

5. The overman in each shift shall bring the hand plans upto date by showing there on the progress of splits and slices in each of the sections/seams.

6. For easy access from one section/seam to the other for supervision, drift or staple pits with ladders shall be provided at every alternate junction of galleries.

7. Suitable arrangements for communication between the two sections/seams shall be provided by provision of signalling devices or telephones.

8. If at any time, any danger is noticed in any of the sections/seams, persons shall be withdrawn from both the sections/seams.

9. When shot-firing is being done in any of the sections/seams persons should be withdrawn from other section/seam also if the parting between the seam is 4.5m or less.

10. Supports should be erected in both the sections/ seams as per SSR and they shall be as far as practicable vertically one above the another ~~in~~ the two sections/seams.

11. Withdrawal of supports from both the sections/ seams should be done simultaneously

Q. What are the difficulties regarding the thick seam/contiquous seam mining ?

A. The following are the dangers and difficulties associated with mining thick/contiguous seem :-

1. Difficulty in final extraction without loss of coal in goaf.

2. Difficulty regarding maintaining coincidence of verticality of pillars and galleries when development is done in more than one section.

3. Difficulty in final extraction of pillars if verticality between pillars and galleries in different sections is not maintained during development.

4. Difficulty in selection of a method of final extraction of pillars. These difficulties may have to be viewed with respect to the following :-

(i) When seam is developed in more than one section.

(ii) When only bottom section is developed.

(iii) When only top section is developed.

(iv) When development is done in an intermediate section.

(v) When development has been done without having a regard to horizon of the development.

In all these cases, final extraction becomes difficult and entails loss of coal in goaves.

5. Supervision during extraction of pillars simultaneously in top and bottom sections.

6. Difficulty regarding withdrawal of persons from both the sections when any danger is observed in one of the section/seam.

7. Fire hazards due to loss of coal in the goaves.

8. Fire hazards due to induced cracks in the upper horizon of the seam arising out of extraction in a lower section while extraction is done in conjunction with stowing in ascending order of the lifts of the extraction.

9. Danger of explosion due to blown through shots in cavities formed due to falls of roof during extraction of pillars with stowing in a bottom section and when development is being done in an upper lift/section.

10. Danger of influx of gases from cavities of the natures mentioned above.

11. There may be dangers of falls of roof and sides/face in case stowing has been inefficiently done in the lower lift.

12. In deciding upon the panel size where a seam is being worked in more than one section or whether contiguous seams are being worked, the size of the panel should be fixed according to lowest incubation period of one of the sections/seams and

this mean loss of coal in barriers in the section/seam which has longer incubation period.

13. Danger of blown through shots when two section/seams are worked within 4.5 m of each other and consequent difficulty associated with withdrawal of persons from both the sections/seams to avoid danger.

14. When two section of same seam or two contiguous seams are developed separately at different periods of time and pillars formed earlier in one of the section/seams are kept isolated by stoppings for sectionaliation purpose, there may be danger of the panel so isolated being filled up with CH_4 – air moisture which will cause potential danger of explosion when the other section/seam is being developed with the explosives (Degassification).

15. Danger during sealing off fire areas in one of the sections/seams, in such cases, the stoppings are required to be provided around the fire areas in such a manner that the barriers around the fire areas and around area, in the other section/seam are vertically superimposed. But even after such sealing, slip planes or even prominent cracks in coal may allow leakage of product of combustion (POC) outside the sealed off areas.

16. If fire area is sealed off leaving coal in the roof and stoppings are provided with foundation in the coal roof, the possibility of fire jumping out of the sealed off area along the roof coal or carbonacious shale in the roof can't be ruled out.

17. Danger of inundations from one section/seam to the other through the collapse of parting, through bore holes, staple pits, fault planes, presence of shaft from the surface interconnecting the sections/seams etc.

18. When there is accumulation of water in one of the sections/seams or even danger of inundation from any surface source of water in one of the sections/seams is likely to be transferred to the other through interconnection, collapse of parting etc.

19. Thick seam mining causes problem of strata control.

Q. What are the main problems associated during winning pillars ?

A. During exploitation of the long standing pillars, the following problems may be encounterted :-

1. Heavey developed stress and strain on the pillars due to long standing.
2. Converagence of roof and heaving of floor in the gate road at greater depth.
3. Spontaneous heating of coal and fire in the panel.
4. Effect of extraction stress in adjoining barrier pillars.
5. The effects of subsidence and interaction on the other seams.
6. Presence of railways, roads, township, rivers etc. situated on the surface.
7. Pecesence of water logged seams above the coal seam being extracted.
8. Presence of fire in the seam or in the above/below seams of the seams to be extracted.
9. Restriction imposed by the laws, rules and regulations for the protection of the surface.

10. Gassiness of seams ad influx of noxious gases.
11. Dangers from crushing/collapsing of pillars.
12. Limitation of extraction height which is governed by the max. extension of the standing pillars.
13. Efects of depillaring in the adjoining mines.
14. Problems due to geological disturbances.
15. Lack of supply of required materials.
16. A tedious preparetory works for mine ventilation and there may be environmental problems.
17. Doubts regarding adaptibility with the new system by the officers, supervisory staffs and miners.
18. High investment and cost economic etc.

Q. What are the statutory provision for working below railway ?

A. Following are the statutory provisions for working below railway.

1. If any working is intended to abandon or discontinue for more than 60 days, any working below ground over which is situated any property vested in the Govt. or any local authority or any railway or any building or permanent structure not belonging to the owner, agent or manager, shall not less than 30 days before the date of such abondenmrnt or discontinuence give notice of his intention to the CIM and RIM.
2. No. workings shall be made and no work of extraction/reduction of pillars shall be conducted at, or extended to, or extended to any point within 45m of any railway, or any Public works or any

public roads or buildings or of permanent structure not belonging to owner of the mine, without the the prior permission in writing of the CIM and subject to such conditions as he may specially therein, - CMR-105(I)

3. A copy of the application shall be sent to railway administration and authority of public works as the case CMR-105(2)

4. A copy of the application for permission under Reg.105(1) shall also be sent to the following authority along with DGMS

(a) Aerial ropeway :- The public authority owning the aerial ropeway.

(b) High-tension transmission lines :- The authority owning transmission lines.

(c) Water and gas mains above 60 cm diameter :- Authority owning water or gas mains.

5. In order to keep a check on the condition of workings (both present and disused) beneath and within the statutorily restricted areas for .

a) Rivers and jores etc.

b) Roads and railways.

c) Dwellings and other structutes.
A regular inspection of such workings should be made once atleast in every month by a person holding an overman certificate or manager's certificate and written record of such inspections should also be maintained and duly countersigned by the manager. Such workings should be inspercted once atleast in every 3 months by the manager personally.

6. As long as the mine workings on the outbye side of the workings in the restricted areas are not depillared, at least two such approach roadways should as far as possible, be maintained in good condition. Before the approach roadways are cut-off, however, the owner, agent or manager shall ensure that the restricted workings under the surface feature are in stable condition or have been stabilised and and should give the RIM atleast, 30 days notice of the intention to cut off the approach roadways.

7. Protective work before a mine in closed, is to be done.

Q. What are the statutory obligations while working near mine boundaries ?

A. Following are the statutory obligations while working near mine boundaries.

1. The owner, agent or manager of a mine, shal before the commencement of any mining operation give notice in form I to CIM, controller (IBM), DM and a copy thereof shall be submitted to RIM with a plan showing the mine boundaries, This notice shall be so given as to reach the persons concerned atleast one month before the commencement of any mining operation.

2. The surveyor shall record in a bound paged book kept for the purpose, the full facts when workings of the mine have approached to about 75 m from the mine boundary.

3. a(i) The surface plan and the u/g plan shall show the settled boundary of the mine or where the boundary is in the dispute, the boundaries claimed by the owner of the mine and the ownwer of the adjacent mine. If complete leasehold can't be shown on the same plan an additonal key plan on

any other suitable scale showing such boundaries and the outline of the workings shall also be maintained.

ii) The u/g plan shall also show the workings, and all features as prescribed in above clause, both above and below ground of all adjacent mines as are situated within 60m, measured on any plane, of the boundaries claimed by the owners of the mine.

b) The owner, agent and manager of every mine shall as soon as its workings extend to within 60m of the settled boundary with an adjacent mine (or where the boundary is in dispute within 60m of the boundary claimed by the owner of the adjacent mine) inform the owner. Agent or manager of such mine about the fact of such extension.

4. Statutory precautions are required to be taken as in case of multi-section and contiguans working.

5. Workings under railways and roads as required under CMR-105.

6. a) Every mine shall have fixed boundaries of mines and this shall not be changed except with in express permission in writing of CIM. If the boundary of a mine is changed, a plan showing the new boundary shall be submitted within 7 days.

b) No workings shall be made within a distance equal to half the distance of pillar (length) corresponding to the depth, of the boundary of any mine. No workings shall be made within the aforesaid distance from the boundary claimed by the owner of the adjacent mine (disputed boundary) until the dispute has been settled.

Provided that where work is done in more than one seams the barrier kept at the boundary, shall , as far as practible, be vertically coincident and of the same dimenion.

c)The C.I. may, however, by an order in writing and subject to such conditions as he may specify there in, permit the workings of any mine or part thereof to extend within any shorter distance than what is statutory laiddown above or may require that the said workings shall not extend further than a specified distance.

7. Prior approval of the CIM should also be obtained whenever it is intended to cross boundaries and/ or 15m statutory barrier between two adjacent mine under the control of different managers after the amalgamation etc.

8. Where the workings of any seam for any reas .., may extended or get extended within any shorter distance than laid down in 6(c) the CIM may by an order in writing, require the owner to construct such protective works within such time as he may specify in the order.

9. If the adjoining mine is water logged, permission under Req. 127 is required.

Q. What are merits of Long Wall system of mining ?

A. Merits of L/W Systwm of Mining :-

1. Concentation of mine operation.
2. Continuity of operation.
3. Higher % of extraction.
4. Higher production & Productivity.
5. Better subsidence control.
6. Improved Safety.
7. Greater feasibility of winding operation at greater depth
8. Reduction of number, of L/W districts.
9. Better mining method for thin and thick seam and also for multiple seams.
10. Means of easier ventilation and environmental control.
11. Enhances % of extraction with the help of Pump-Packing system.

Q. What are thebest application conditions for Long Wall system of mining ?

A. BEST APPLICATION CONDITIONS FOR L/W SYSTEM :-

1 Seam thickness varying from 0.4 to 6m in single slice where thick seam is to be worked mainly either by multislicing system or integral or sub-level caving system.However, the system is more productive in seam whose thickness varies from 2m to 3m.

2. Flat and moderetrly inclined seams are best for this method.

3. Coal of moderate hardness is suitable for this method.However, very friable and soft coal or very hard coal are less suitable for this system.

4. Uniform seam thickness, free from geological disturbances like faults, folds, hoghly fractured are best suitable.
5. Immediate roof not too hard or not too weak.

6. Strong floor condition.

Q. What are reasons of low productivity of Indian L/W system ?

A. REASONS OF LOW PRODUCTIVITY OF INDIAN L/W SYSTEM.

1.Planning lacuna.
2.Mismattch of equipment to the geotechnical environment of L/W site.
3.L/W faces were mechanised but total system were not fully mechanised.
4.Difficult strata control problem.
5.Presence of geological disturbances like faults, fractured roof condition stone intrusion, dykes etc.
6.Inadequate hoisting, transporting and u/g. storing capaciity of coal.
7. Lack of back- up supply.
8. Lack of availability of spare parts and their development indigeneously.
9. Inefficient spares parts management including inventory control.
10. Non-standarisation of equipments.
11. Non-availability of suitable workshop facility.
12. Inadequate earth protection facility. (Insulated neutral or restricted neutral system)
13. Non-availability of a new L/W panel due to poor drivage.
14. Lack of trained manpower.
15. Socio-political condition.
16. Lack in aptitude trait.
17. Recruitment of unskilled manpower in mechanised face.
18. Insufficient physique to work with heavy duty modern L/W equipments.
19. Insufficient accomodotion facility.
20. Lack of motivation.
21. Improper machine maintanance system.

Q. What are coal bumps ?

A. These are sudden release of strain energy inside walls or coal pillars.

Pressure Bumps : When Pillars go on accumulating strain energy under sustained pressure they tend to release it with violence. These are called Pressure bumps.

Shock Bumps : When a hard and massive bed of rock which overhangs in goaf suddenly breaks off it, transmits large amount of strain energy in the coal at the goaf edge causing a bump known as shock bump.

$$\text{Energy index, } W = \frac{\text{Elastic strain energy accumulated}}{\text{Permanent strain energy}}$$

W	Proneness
>5	Severely liable to bumps
2-5	Slightly liable
<2	Not liable

Coal bumps has occured in following mines :-

(i)Sodepur (No-9,10&11 pits) colliery - Dishergarh seam
13 killed

(ii)Dhemo main colliery - Dishergarh seam
12 killed

Q. What is cavability index ?

A. Cavability index :- It is a rock Parameter which indicates the competency of rocks and its caving behaviour.

$$\boxed{I = \frac{\sigma\, t^{0.5} \times L^{n}}{5}}$$

Where
I = cavability index
σ = compressive strength of rock(kg/cm^2
L = Average length of core (cm)
T = thickness of strong bed (m)
n = 1 to 1.2 depending upon average value of R.Q.D.

value of I (Max)	Nature of roof
2000	Easily cavable
5000	moderately cavable
10,000	cavable with difficulty
14,000	cavable with substantial difficulty
17,000	cavable with extreme difficulty

Higher is the cavability index, rock is difficult to cave.

Q. What is RQD ?

A. Rock quantity designation (RQD) :- This is also a rock parameter which is used for classification of rock mass and is defined by the following relation:

$$\boxed{R.Q.D = \frac{\Sigma l}{L} \times 100}$$

Where Σl = sum of length of drill cores greater than 10 cm
L = total length drilled in rock = 4.57 m (roof rock overlying the coal seam, core dia - 54 mm

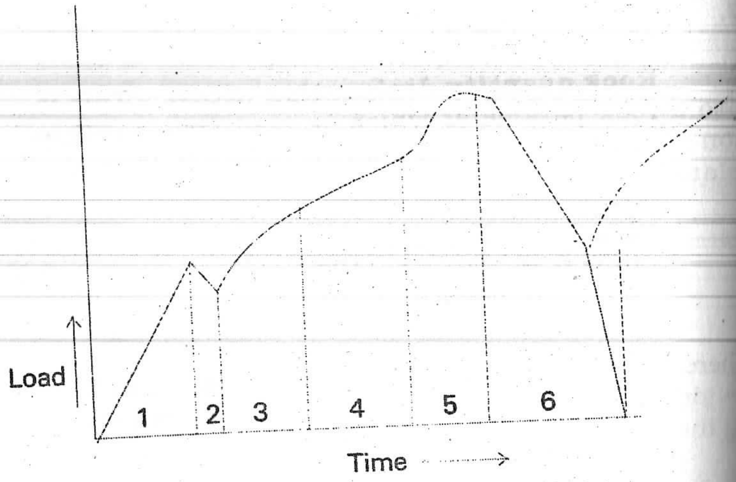
RQD	Class of rock
0 - 25	very poor
25 - 50	poor
50 - 75	fair
79 - 90	good
90 - 100	excellent

Two rocks with same RQD value may behave differently over on opening.

Q. Discuss the loading characteristics of power support with the help of graph .

A. Loading characteristics of powered support :-

1.setting load
2.setting load cut off
3.intensive convergence
4.decelerated convergence
5.peak load
6.valve release



1. Setting load in the form of steeply rising straight line.
2. Pressure drop on closing the valve
3. Pressure rise in the form of clearly expressed curve characterising rock compaction over the support (intensive convergence)
4. A flattened curve indicating the delayed rock compaction when decelerated convergence takes place.
5. A curve of sharp load increase takes which exposes aditional roof area. This is the peak load on the supports.
6. A straight line when pressure drops on releasing the props and advancing the chock .

Q. What is RMR ?

A. Rock mass rating is a rock parameter. It is a geomechanics system of rating of stability characteristics of roof rock in a coal mines.

RMR depends upon Layer thickness, structural features , weatherability , strength of roof rock & ground water seepage.

Higher the RMR, better is the roof .

Parameter	Maximum rating
Layer thickness	30
Structural features	25
Rock weatherability	20
Strength of rock	15
Ground water seepage	10
RMR = Σf ( ) =	100

RMR	Class of roof	Description of roof
0 - 20	V	very poor
21- 40	IV	poor
41 - 60	III	fair
61 - 80	II	good
81 - 100	I	very good

Q. What do you mean by Convergence ? What are the factors affecting the convegence ?

A. It is defined as the relative displacement between the two poits, which occurs due to roof sagging, sequeezing of rockmass or coal, heaving of floor etc. and it is directly proportional to the supporting resistance applied to the roof.

Factors affecting the convergence :-

- Mean load density (P)
- Cavability index (I) of strongest bed casusing the weighting
- Rate of face advace
- Distribution of stresses
- Local geology
- Thickness (t) of immediate cavable bed in-between strongest bed and coal seam in terms of height of extraction.

Faster the rate of face advance, less would be the amount of convergence.
The maximum convergence (generally occuring during periods of weighing) is given by the relation :

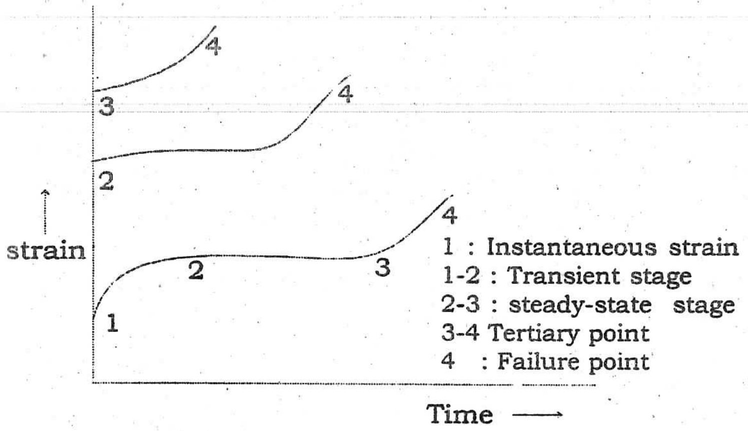
$$Cm = \left(\frac{A}{P} + 35\right)\left(\frac{KI}{t+1} - 23\right)$$

where
A= a constant depending upon nature of roof rock
P=Mean load density
K=another constant depending upon Value of t
I=Cavability index
t= thickness of cavable bed

Value of Cm (mm/m)	Category of roof conditio
≤ 60	I (Good)
≤ 100	II (Moderate)
> 100	III (Poor)

Q. What is Creep of rock ?

A. It is elastic behaviour of rockmass under applied load. When rockmass or coal is subject to constant load, the rockmass/coal deforms increasingly with time. This is known as creep of rockmass / coal. The variation of strain with time is given below :



Various curves for Creep of rook

From the above graph it is clear that under constant load an elastic strain will develop instantaneously over the rockmass / coal. The strainwill increase linearly depending upon time as shown by (1-2), known as transient stage afterward a steady - state stage (2-3) is reached in which strain becomes constant. From the point 3, the strain increases rapidly with time and ultimately the rockmass/coal fails at the point 4. The portion of the curve (3-4) is known as tertiary stage. It is also clear that steady-state stage is in longer duration compare to the other stages.

If more load is applied then there will be no transient stage and if the appliedd load is severe then only tertialry stage will remain.

Subsidence

Q. What is subsidence ?

A. It is defined as the vertical downward movement of any point of ground in a subsidence Profile. Vertical movement by less than 5mm are neglected. Limit of subsidence is defined as vertical movements of all points which subside by 5mm.

Q. What is residual subsidence ?

A. It is the difference between final subsidence trough and instantaneous subsidence trough.

Q. What is difference between maximum subsidence and maximum possible subsidence ?

A. Maximum subsidence (s) is the maximum subsidence over a panel with sub-critical width-depth ratio of extraction.

The maximum possible subsidence (Smax) is the maximum subsidence over a panel with critical or super - critical width depth ratio.

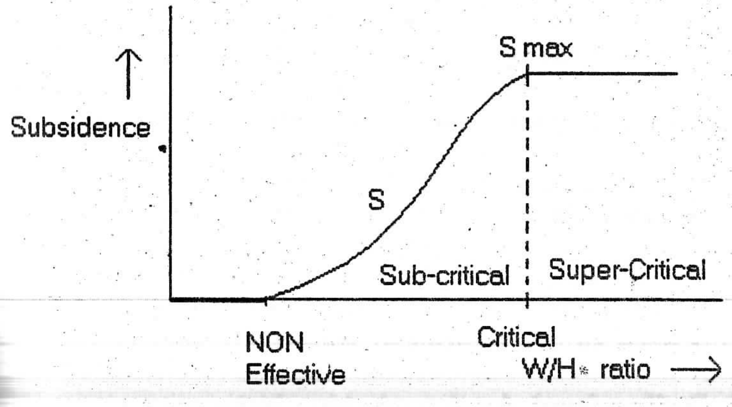
Q. Define the folowing terms :-
(a) Critical width depth ratio
(b) Non-effective width-depth ratio
(c) Sub-critical width-depth ratio
(d) Super critical width-depth ratio

A.(a) Critical width depth ratio : It is defined as the width-depth ratio of extraction under ground which causes complete or maximum possible subsidance at a point on the surface.

(b) **Non effective width-depth ratio :** The maximum width-depth ratio of extraction under-ground which does not cause practically any subsidence on the surface.

(c) **Sub-critical width-depth ratio :-** The width-depth ratio of extraction underground which is more than non-effective width-depth ratio but less than the critical width-depth ratio. Extraction of sub-critical width-depth ratio does not cause maximum posible subsidence at any point on the surface.

(d) **Super Critical width-depth ratio:-** The width-depth ratio of extraction underground which is more than the critical width-depth ratio. Extraction of super-critical width ratio causes complete subsidence over an area on the surface.



Q. What is subsidence factor ?

A. It is defined as the ratio of maximum possible subsidence to thickness of extraction.

Q. What is angle of draw or limit angle?

A. It is defined as the angle between the vertical and the edge of subsidence trough from the edge of an underground working.

Q. What is angle of break or angle of fracture?

A. It is the angle between the vertical and the point of maximum tensile strain from the edge of an underground working.

Q. What is strain?

A. It is defined as the horizontal extension or compression of ground per unit length.It is measured in mm/metre.

Q. What are factors affecting the subsidence ?

A. Subsidence depends upon following factors:-
(1)Angle of draw (2) Seam thickness (3)Width-depth ratio of extraction u/g (4) Time (5)Dip of seam.

Q. What is abutment zone and abutment Pressure ?

A. Abutment zone is the zone adjacent to an excavation underground which normally experiences increased stress as a result of re-distribution of load of superrincumbent strata.

Abutment pressure is defined as the load per unit area in the abutment zone.

Q. Define front, back and side abutment.

A. Front abutment :- It is the increased stress zone infront or ahead or in advance of a face.

Back abutment :- It is the increased stress zone at the rear or back or behind a face.

Side abutment :- It is the increased stress zone at the side of a face.

Q. What is point of inflextion?

A. These are the points on the subsidence curve at which the curvature changes from positive to negative. Infact, curvature changes twice on subsidence profile.

Q. How subsidence is controlled by Mining activities ?

A. The following methods are generally adopted for controlling subsidence :-

(i) Partial extraction of pillar
(ii) Limited width of excavations
(iii) Stowing or Packing
(iv) Harmonic mining
(v) Rapid mining
(vi) Leaving barriers

Q. What is Pot-holing?

A. Pot-holing is the fall of ground upto the surface with roughly parallel sides.This generally takes place in shallow workings over roadway junctions, especially if there is a thick loose over budden. The loose materials acts as a dead weight and shears the strata.Potholes can occur upto about 50 m of depth.

Mine Fire and Explosion

Q. What is initial temperature ?

A. It is the minimum temperature beyond which it is not possible to prevent progressive rise in temperature due to spontaneous heating.

Q. What is incubation period ?

A. The period between which the coal is first subjected to conditions favouring self heating to the point of reaching ignition is known as incubation period.It is also defined as the period between the first roof fall after beginning of coal extraction in a district or panel and the apearance of first signs of heating.It usually varies between 3 to 18 months, higher rank coals having longer periods.

Q. What are the disadvantages in using water for mitigating fires in gallery ?

A. The disadvantages are:

- (i) Chances of backlush
- (ii) Frequent roof fall
- (iii) One end fire quenched but other end fire increases.
- (iv) If less quantity of water is used, there are chances of water gas formation and water gas explosion .
- (v) Stoppage of ventilation.

Q. What is young's ratio ?

A. It is defined as the ratio of CO_2 produced and O_2 absorbed.

$$\text{Young's ratio} = \frac{CO_2 \times 100}{O_2\ \text{deficiency}} = \frac{100\ CO_2}{0.265\ N_2 - O_2}$$

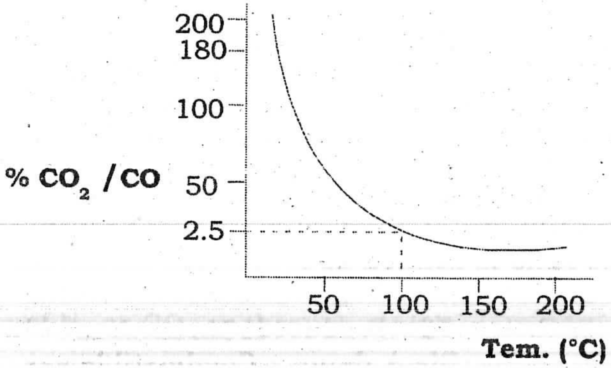
The normal make of co2 should be known in some detail before it can be used to provide evidence of progress of heating or fire. If the normal make is negligible then the plot of co2 and co2/o2 ratio is used to judge the change from heating to an open fire as it progresses to higher values and then decreases towards a value to zero.

Q. What is Morris's ratio ?

A. It is defined as the ratio of co_2 and co .

$$M.R. = \frac{CO_2}{CO}$$

It has been used to estimate the tem and hence progress of heating.

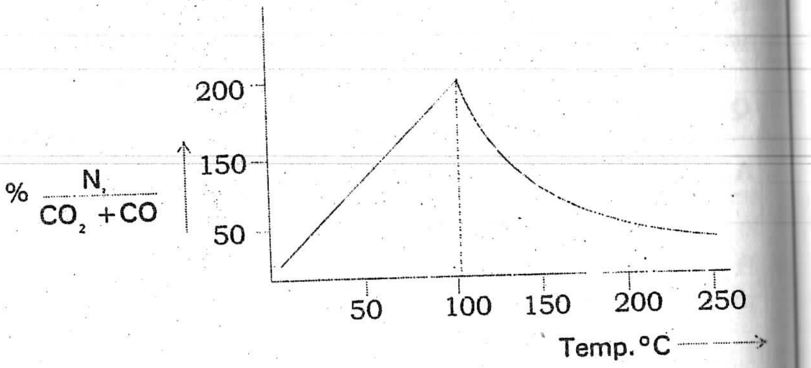


This ratio serves as a useful indicator of temperature increase during the initial development of heating .This index can only be used when no co2 occurs naturally in the strata

M.R. can also be defined as :-

$$M.R. = \frac{N2}{CO_2 + CO}$$

It has been used to estimate the temperature of heating . It is sensitive to change in the state of gases within a sealed fire zone. The variation of this ratio with temperature is shown in Fig. below :

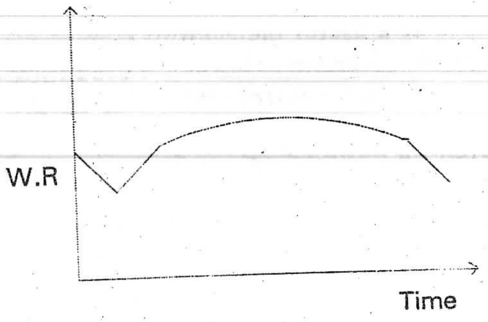


This ratio is valid only when all co_2 orginates from the heating and can't be used when N_2 injection is employed as a means to control the heating.

Q. What is Willet's ratio ?

A. This ratio is defined as :

$$W.R. = \frac{CO_2\ \text{Produced}}{\text{Black damp + Combustible gas}} \times 100$$



This ratio is based on all the gases in a sample other than air and expresses the co2 content as a percentage of these gases.

This ratio rises fairly sharply (there may be slight initial fall in some cases) after a fire has been sealed off. Even after the fire is extint, the rise may continue but at a diminishing rate of increase until it becomes stable or begins to fall. The trend of this ratio can be used as an index of the progress towards extinction of fire behind the seals where Graham's ratio is not applicable.

Q. What is Jone's and Tricket ratio ?

A. This ratio is defined as :

$$\text{J.T.R.} = \frac{CO_2 + 0.75\,CO - 0.25\,H_2}{0.265\,N_2 - O_2} = \frac{CO_2 + 0.75\,CO - 0.25\,H_2}{O_2\ \text{absorbed}}$$

This ratio may be used for both explosibility and state of fire interpretation . This ratio will not work if the air reaching the fire is O_2 deficient through injection of N_2 or CO_2 or through a high make of methane.

JTR	**Status**
0.5	Fire damp explosion
0.87	Coal dust explosion
0.5 - 0.87	Mixed explosion
< 0.4	Fire

Q. What is index of hydrocarbon ?

A. This is the new concept used by U. S. B. M. for status of heating in a sealed off fire area in U/g. This is based on mine air samples.

Index of hydrocarbon (R) is defined as :

$$\boxed{R = \frac{1.01\,(THC) - CH_4}{(THC) + c} \times 100}$$

where, THC=total hydrocarbon in PPM
CH_4=methane in PPM
c= a constant having value of 0.01

Value of R	Condition
0 - 50	Normal
50 - 100	Possible heating
100 - 1000	Serious heating
> 1000	Fire

Q. What are the circumstances under which stone dust barriers may fail ?

A. Stone dust barriers may fail under any of the following circumstances :-

(i) When the barrier itself lies in a flammable CH_4 air mixture or fire damp occurs as a roof layer .

(ii) When flame velocities are high (> 500 m/s) as when a dust explosion is initiated by a powerful fire damp explosion or assisted by firedamp during its propagation.

(iii) When the barrier is located less than 40-60mor far from a face or other potential point of ignition, so that the dynamic pressure is less than the minimum required (3-5 KN/m²)

(iv) When an explosion is initiated by a weak ignition source and suficient dynamic pressure is not built-up.

Q. What is lag on ignition ? What is their utility ?

A. It is defined as the time interval between the exposure of CH_4 air mixrure to an igniting source to the appearance of flame.

Lag on ignition falls with rise in temperature of the source of ignition. It also falls with increasing presure but to a much lesser extent. It also falls with the pressure of H_2 or other combustible gas.

Temp. of Source of ignition	**Lag on ignition**
650°c	10 sec
1000°c	1 sec
1200°c	1/15 sec
2200°c	0

Use of lag on ignition :-

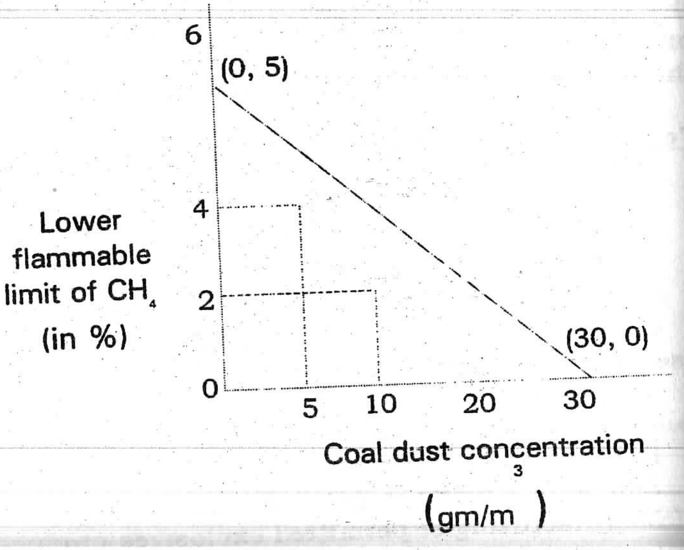
1. Designing flame safety lamp
2. Designing FLP construction
3. Safe shot - firing in gassy mines
4. Manufacturing of permitted explosives producing very - short duration flame.
5. Delay interval between first and last defonator

Q. What is ignition temperature ?

A. It is the minimum temperature to which a portion of CH_4 - air mixture must be raised in order to initiate or cause rapidly accelerating reaction in the whole of the accumulation of mixture with the accomplishment of a flame. It is always less than the temperature of igniting source. It depends upon the nature of source of ignition , CH4 content , temperature of surroundings, pressure, O2 concentration pressure of other gases etc. The ignition temperature of pure CH_4 in oxygen is 550°C.

Q. How lower flammable limit of firedamp varies with dust concentration ?

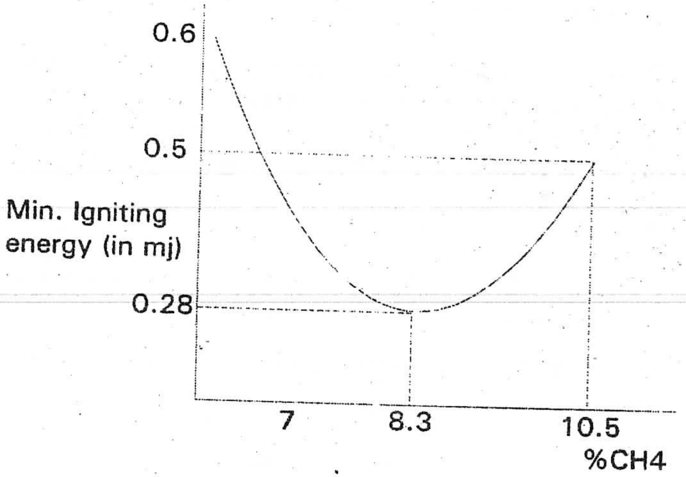
A. The lower limit of flammability of CH_4 is found to be independent of O_2 concentration above 20 % . It decreases linearly from 5 % to 0 % as the air - borne coal dust concentration increases from 0 to its lower limit of flammability (30 gm / m^3).
The graph below shows the variation.

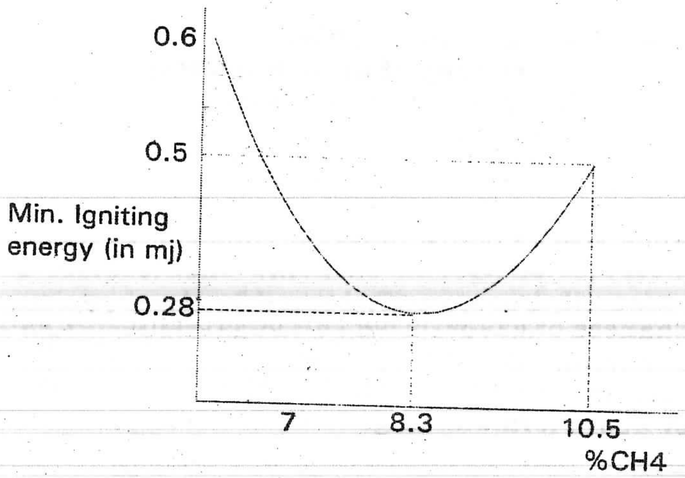


Q. What is minimum energy of spark ?

A. It is defined as the minimum energy required fo the ignition of explosive mixture. The minimum energy of spark causing an explosion is as little as 0.2 mj at 8.3 % CH4 . The minimum energy level varie from 0.6 to 0.28 mj for gases 7 to 8.3 % and 0.28 mj t 0.5 mj for the range 8.3 to 10.5 %.

The variation of minimum energy of spark with co centration of methane is shown on the next page.





Q. What is explosion dust ?

A. Explosion dust is dust deposited from the cloud raised by the explosion which settles after the explosion and died down , only part of which may be traversed by the flame.

Q. What is layering number ?

A. It is a number which indicates the proneness of layering of methane gas .The effect of velocity of air and rate of emission of CH4 on proness of layering is given by a number called layering no.Ln and is expressed as :-

$$L_n = V\left(\frac{D}{4.3Q}\right)1/3$$

where Ln = lawering number
V = velocity of air flow (m/sec)
Q = quantity of gas emitted into the airway (m3/sec)
D = width of gallery (m)

Chances of gas layering can be prevented by suitably designing the roadway dimension and velocity of air such that its Ln is never less than 3 when calculated by above formula. In general, Ln > 3.

Layered gases are very rich in CH4 % but when it is agnited convection currents will be produced and gas mixture may come within explosive limits to explode .Layered gases could be mixed with air by roof falls , blasting , ventilation current , moving men and machines or by combustion reactions.

Q. Define ignition, inflammation, propagation and explosion.

A. Ignition : When the flame is in contact with the source of ignition, it is called ignition.

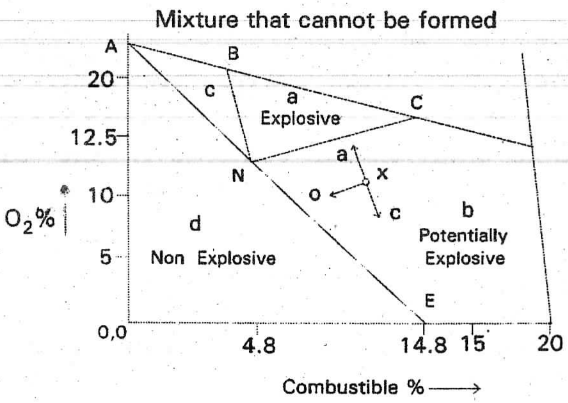
Inflammation : In inflammation, heat is transferred from point to point in the mixture by radiation and convection. There is rapid increase in temperature and pressure of expanding gases. Each layer in succession of unburnt gas compressed adiabatically and raised to ignition temperature. When this stage is reached, the propagation attains high velocity.

Propagation : It is continued inflammation of gas or dust through the mine passages as far as the gas or dust zone extends.

Explosion : It is practically synonymous with propagation but it is associated with considerable dynamic force and advances as the moving zone of combustion at tremendous velocity.

Q. What is Coward's triangle ?

A. It is an explosibility diagram which clearly shows those compositions which lie in regions representing various levels of hazard .The coward diagram is also useful as an indicator of the effect of changes in composition on explosibility.



From the above diagram, it is clear that mixtures in region 'a' are explosive (capable of propagating flame after ignition), those in region 'b' can become explosive on dilution of air , those in region 'c' are non-explosive but can become explosive on reduced dilution with air and those in region 'd' are not capable of forming explosive mixtures owning to their high content of inert constituents.

If a mixture is diluted with air , the point representing it on the diagram will move towards region 'a' . Dilution with inert gases will cause a sample point to move towards the origin 'o'. Increasing the cumbustible content of the mixtures causes a shift in 'c'.

The interpretation of this diagram form the basis for the expert systems evaluation of the effect of ventilation and the dangers associated with different courses of action during the fighting of a sealed -off fire.

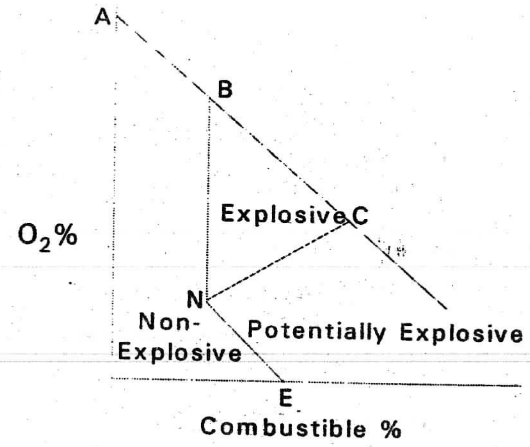
Q. What is Ellicott diagram ?

A. It is a modified form of the coward diagram which is obtained by performing a transformation on the diagram for a gas mixtures yield cartesian co-ordinates (x,y) that convey essential informations on explosibility.

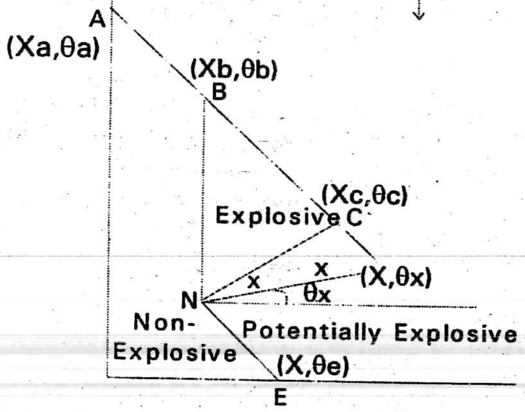
In the original method, the status of a gas mixture is a function of the lower and upper explosive limits ,the combustible and oxygen content of mixrure corresponding to the nose point , (Cn, On), and the actual combustible and oxygen contents of the sample (ΣC, O_2). The simplifying transformation may be expressed as :

$$f(LEL\ ,UEL,Cn,\ On,\ \Sigma C\ ,\ O2\ ) \longrightarrow f\,(Xm,\ Ym\ )$$

Where Xm and Ym are modified co-ordinates for the mixture. The effect of this transformation and the correspondence between the regions of a coward dia-

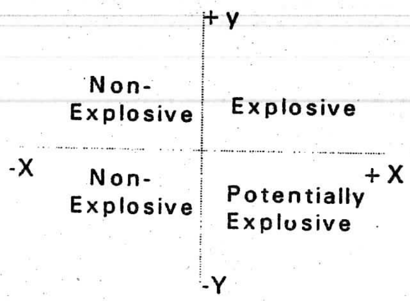

A
B
Explosive
C
O_2%
N
Non-
Explosive
Potentially Explosive
E
Combustible %

Coward's diagram


A
(Xa,θa)
(Xb,θb)
B
(Xc,θc)
Explosive
C
x
X
(X,θx)
θx
N
Non-
Explosive
Potentially Explosive
(X,θe)
E

Polar form

Ellicot'sdiagram


+Y
Non-
Explosive
Explosive
-X
Non-
Explosive
+X
Potentially
Explosive
-Y

Ellicot'sdiagram

The ésian co-ordinators are first convert topolar form ith the origin at the nose point, N and subsequently converted back to rectangular co-ordinates . The explosive status of a gas mixture is indicated by the signs of xm and ym. The trends can be monitored and plotted on this simple diagram whis has the same directional properties as the original coward triangle.

Criterion	Interpretation
$\phi c < \phi x < \phi b$	Mixture explosive
$\phi b < \phi x < \phi a$	Mixture non-explosive but may explosive on reduced dilution with air
$\phi b < \phi x < \phi c$	Mixture non -explosive
$\phi x < \phi c$ or $\phi c < \phi x$	Mixture potentially explosive

Q. Define the following terms :
(a) Crossing point temperature
(b) Ignition temperature
(c) Trigger temperature

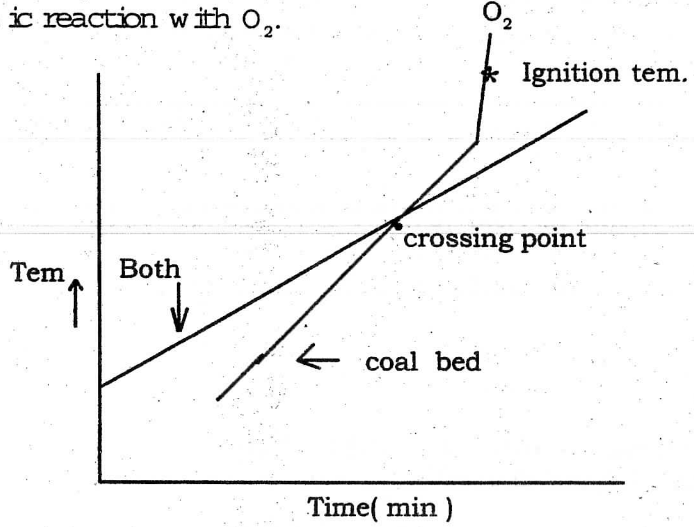
A. (a) Crossing Point tem :- Temperature at which the the tem. of coal and the furnance / bath coincides is the crossing point of coal. It is measure of status of heating.

T > 160 °C; Moisture < 2 % - Poorly susceptible to sp heating.

T=140°C - 160°C Moisture 2-5% - Moderately susceptible to sp. heating

T=120°C - 140°C Moisture >5 %- Highly susceptibl to sp. heating.

(b) Ignition tem :- It is defined as the Minimum tem. at which the coal ignites (catches fire) without addition of external source of heat on account of exothermic reaction with O_2.



(c) Trigger temperature :- Temp. at which chemical reaction between coal and (60°- 70°c) O_2 takes place at very fast is called trigger tempeature.

Q. What is explosibility index of coal dust ?

A. The severity and destructiveness of coal dust explosion is related to its ease of ignition, maximum explosion pressure, maximum rate of pressure rise and confinement.
Explosibility index is defined as the product of ignition sensitivity and explosion severity. Ignition Sensitivity depends on ignition temperature and minimum ignition energy where as explosion severity depends upon maximum explosion and maximum rate of pressure rise.
Higher is the explosibity index, stronger is the coal dust explosion.

Explosibility index	**Type of Explosion**
< 0.1	weak
0.1-1	moderate
1-10	strong
> 10	severe

INUNDATION

Q. What are the circumstances in which HFL of a river can change ? What precautions are required to be taken in such circumstances ?

A. Circumstances in which HFL of a river can change

(i) Heavy rainfall
(ii) Silting of river bed
(iii)Blockage on downstream side
(iv) Other tributary on upstream side

Following Precautions are required to be taken when HFL of a river has changed

(i)checking of all openings whether height is more than 1.5 or 3m of HFL.

(ii) Guarding by providing embarkment.

(iii) Permission for caving if subsided area above HFL

(iv)Fresh permission to be taken if previous permission granted on old HFL

(v) Checking of subsided area if existed whether the elavation is 3m more in respect of new HFL.

Q. What are the factors required to be taken into consideration regarding the thickness of barriers to be left against water logged workings ? How this could be ensured that the left barrier thickness is adequate ?

A. There are two main considerations for coal barriers to be left to resist water pressure –

(a) The accuracy and reliability of information and its gathering either by proof or interpolation from available evidence such as records and plans.

(b) **The design parameters of barriers :** The barrier is subjected to loading by super incumbent strata and is to resist a pressure exerted by water.

Factors influencing size of a coal barrier against water-logged workings :-

(i) Strength of material/nature of coal

(ii) Presence of geological disturbances like faults

(iii)Water pressure exerted against the coal

(iv) Strata Pressure (depth of cover)

(v) Frictional resistance to the movement- coefficient of friction between coal and roof strata and between coal and floor strata.

(vi) Inclination of seam

(vii)Other loads thrown into the edge of the coal by extraction
(viii)Other workings above or below can result in stressing of the barrier.

Adequacy of barrier :-

(i) Barrier pillar must be stable under strata pressure and total water pressure against it.

(ii) Pillar size according to depth of cover.

(iii)Resisting force along the floor and roof whether adequate or not.

The thickness of barrier can be ascertained by the following methods :-

(a) Boring – Long boreholes with the help of hydroboring appratus fitted with adequate safety appliance(burn-side boring apparatus) should be drilled to ensure the thickness of a barrier.

(b) By G.P.R. – Ground penetrating radar (Geo-radar) can be used to ascertain the thickness of coal barrier.

(c) By Geo – physical surveying – Magnetic, seismic, electrical and radioactive techniques are used to ascertain the thickness of barrier.

Q. What particulars are required to be shown on mine plan to know the dangers of inundation ?

A. Particulars to be shown on mine plan to assess the danger of inundation are river with opening, R.L. of all openings of cover, section of strata, joint survey done, culvert, bridge, quarry etc, spot level at roof level, shape of gallery and pillars, subsided area, angle of draw whether connected to water logged workings, adequacy of barrier (with specifications and certification), ends of workings marked with the last survey or not, fault and its head and throw, faults whether connected to water logged workings or not.

Q. Give your comments on adequacy of statutory provisions against dangers of surface source of water.

A. Comments on adequacy of Regulation 126 :

1. The regulation should provide that permission should be taken from R.I.M for working below any point within a horizontal distance of 60 metre instead of 15m.

2. Reg. 126(1) (b) requires that any new opening should be made at a place which is atleast 1.5m above the HFL at that point. This difference of level should be made at least 3m as in most of the rivers flash floods may not be ruled-out for several reasons.

3. The regulation should provide that if a fault plane is connected with any water bodies on the surface, a barrier of at least 7.5m thick should be left against such fault plane.

4. In case of mines situated by the side of the rivers, the following precautions may be required to be complied with by the regulation :

(a) Before the on set of rainy season, all water courses should be inspected and steps should be taken to see that any obstructiuons in the course of river are removed to ensure free flow of water.

(b) Withdrawl points shall be fixed consdering the time required for the communication of the danger, evacution of persons from u/g workings and safety margin in view of the delays which may be involved in withdrawl of persons.

(c) The embankment provided against high flood waters should be designed and constucted on engineering parameters.

(d) A foolproof system of communication shall be maintained between the observation points near the embarkments and the top of the mine openings, attendence cabin, managers office and residence and also between surface and below ground.

5.The regulation requires that a competent person shall once at least in every 14 days during rainy season examine every protective measures. Such a long time gap is not compatible with safety. Therefore, the regulation should provide that during heavy rain the manager or principal official should go round the surface area of the mines to check vunerable points, effectiveness of the safety measures.

6. The law should also provide that adequancy of intermine barrier shall be ensured. If necessary, the

same shall be restored even artifically by constructing suitable dams, explosion proof stoppings and other methods.

7. There should be provision in regulation for surface sealing of disused pits, potholes and surface subsidence existing in the vicinity of river or surface source of water.

8. There should be provision in regulation for resurvey of rivers and HFL from time to time.

Q. Give your comments on adequacy of statutory provisions against dangers of u/g source of water.

A. Comments on adequency of Regulation 127 :-

1. Every mine vulerable to danger of inundation due to u/g source of water shall be provided with infrastructure for drilling advance boreholes for detecting the presence of water bodies.

2. Prospecting boreholes should be plugged by filling them all completely as some of them may have passed through water bodies in the upper seams or lower seams or the water levels is at a R.L. higher than the points at where persons are working at place of lower R.L. in a higher seam.

3. Permission under reg.127(3) should also be obtained in cases where workings are intended to be advanced towards water logged workings, the extent of which is not known, irrespective of the thickness of barrier shown on available plan.

4. In designing a pattern of boreholes for advancing towards water logged workings, an approval for the design should be obtained from R.I.M.

5. In designing a pattern of advance boreholes, the width of old water logged galleries should be taken as

1m wide as in our country, workings were made in the olden days by drivage of narrow main galleries ahead of the widened gallery.

6. The law should provide adequate precaution for working under the water bearing rocks.

7. The normal seepage of water should be defined in the regulation and there should be provosion for its regular measurement.

Q. Give your comments on adequacy of statutory provisions for working near mine boundaries.

A. 1. When the workings reached within 60m of a mine boundary a fresh co-relation and joint survey should be made to ensure that the plan is correct.

2. Every mine plan should be connected with at least two points of national grid so as to have a fixed geographical position so far as the boundary is concerned.

3. For making a co-relation survey as aforesaid, instrument supplied by the owner only should be used.

4. It must be ensured that the surveyor checks the accuracy of the instrument and if necessary carryout the necessary adjustments.

5. The regulation should also provide that if the workings of any mine get extended to any shorter distance from the boundary as required under regulation, it shall be the duty of owner, agent and manager to report about the same immediately to RIM and CIM in writing.

6. Reg. 107(2) requires the barrier in different seams should inter-alia be of the same dimensions. As dimension includes height also, the law should specify that the barrier should be of same width and length as falls of roof adjacent to the barrier pillar in a seam may make the height of the pillar greater than what

should not be allowed in other seams.

7. The law should provide that if one of the mines adjacent to the common barrier between two mines have been caved and got water logged, extraction of pillars near the mine boundary in the other mine should be so conducted that the lines representing the angle of draw due to caving in two mines do not intersect at a point which is at a lower level than the water level. In rush of water may take place in the working mine due to coalescence of the goaves above the point of intersection as a foresaid.

Q. What essentials are required to be focussed for prevention of dangers due to inundation ?

A. The following essentials to be focussed by technological expertise and legislative body for prevention of dangers due to inundation :

(i) Maintenance of accurate plans and a meaningful reading of the same.

(ii) Identification of the causes of dangers due to inundation from surface sources and from u/g sources.

(iii)Formulating the preventive measures and periodical review of the same for ensuring their sufficiency if there is any changes in the circumstances.

(iv) Strict enforcement of the preventive schedules once formulated.

Q. What statutory or otherwise actions are required to be taken for drowing of a mine ?

A. Following action shall be taken for drowing the area for controlling fire :

1. A 14 day's notice of intentional flodding shall be given to CIM, RIM and management of adjoining mines.

2. The stratum contours in the area will be studied along with the availability of sufficient thickness of barrier around the area to contain water for not only drowning the area affected by fire but upto a distance which may have to be drowned to prevent exposure of the fire due to any seasonal variation in the level of water.

3. For drowning purposes, the availability of water shall be assessed so that large quantity of water can be introduced at a time to minimise the formation of water gas (CO+H_2O) and consequent dangers.

4. Arrangements should also be kept provided to raise the level of water, if due to reasonal variation in the level of water, adverse conditions arise.

5. The area shall be kept submerged under for a considerable period of time for not only quenching the fire but also for dissipation of heat from coal and surrounding strata.

Q. What actions (statutery or otherwise) are required to be taken for re-opening of an area which was kept drowned for controlling of fire ?

A. The following actions shall be taken for re-opening a fire area by dewatering :-

1. A 14 days notice shall be given to CIM and RIM.

2. It must be ensured that the temperature of the coal and surrounding strata in the affected area have gone down to that revelent to geothermic gradient. For this purpose, borerholes may have to be drilled to ascertain the temperature.

3. The area out bye of the water line shall be kept cleared of coal dust and throughly treated with stone dust.

4. Ventilation shall be kept coursed in all the gal-

leries by brattices or other means upto the water face.

5. The operation of de watering shall be conducted under the constant supersision of a competent person. Flame safety lamps, methanometers, cage containing birds and CO detector etc. shall be used for inspection purposes.

6. Flame safety lamps shall be kept burning at the edge of the water where pumping is going on and also at the places where persons are stationed for de watering operation.

7. As the de watering progresses, the workings which gets exposed shall be throughly examined by a competent person for the safety of roof and sides, presence of inf;ammable and noxious gases and for collection of air samples from the return air.

8. The roof and sides of the workings exposed by de watering shall be supported where necessary.

9. If the analysis of air samples/spot detection of gases indicates that Grahm's ratio are found more than the normal to the seam, de watering operation shall be suspended and the area shall be drowned again.

10. If the de watering operation exposes any ventilation/isolation stoppings, they should be suitably repaired.

11. If the study of the stratum contours indicates the presence of any depression or swellings in the area, de watering operation shall be done very slowly to avoid chances of any water blast.
12. While the de watering operation is in progress the exposed workings shall also be inspected to find out if any isolated body of water is compounded on the rise side of the pumping installations against a thin barrier or against debris heaps choking any gallery In such an event, the normal de watering operation shall be suspended and shall not be recommenced until the isolated body of water as aforesaid if first de watered.

13. Care shall be taken by slowing.down the pumping operations when any gallery is likely to be exposed which is connected with any goaf in the same mine or in an adjacent mine, in the same seam or via any drift to any goaf in the upper seam to avoid sudden influx of noxious gases and consequent dangers. Apart from the slowing down the pumping operations, the following another precautions shall be taken :-

(a) The pumping installation and personnel employed for pumping operation shall be stationed on the intake side of the partition screens used for conducting the ventilation up to the water face.

(b) No person shall be allowed to be present on the return side of the partitioned screen or on the return airway.

Q. What prequations statutory and otherwise should be taken when u/g workings are approaching old workings likely to contain water ?

A. Following prequations should be taken :-

(i) The surveyer shall record in surveyor's record book full facts about the workings when they have approached about 65m from water logged workings.

(ii) When the workings have approached within 60m of the water logged workings, drivages shall not be made without obtaining a written permission from R.I.M.

(iii)The exploratery boreholes shall be drilled and records of the same shall be maintained in a bound paged book as required by regulation 127(6).

(iv) Collect all informations about old workings.

(v) Check the plans both of the present workings and also of the old waterlogged workings for accuracy.

(vi) Consult abondoned mine plan (AMP) if such plan is available. Plot the workings shown on AMP on survey of the surface features shown on the AMP and u/g workings and if approachable with reference to a common base line.

(vii) Geological information should be collected and plotted on the plan. These information should include details of faults, permeable strata, water bearing strata and other geological features which may provide a way to the water to enter present working.

(viii) Collect all informations about the workings in any seam above and below the seam being worked in the present mine and also in the mine where the workings are waterlogged. Study the spot levels in the workings if available.

(ix) De water the old workings wherever practicable, as this is the best precaution to avoid dangers.

(x) If de watering is not possible than with the available information calculate the head of water to decide upon the thickness of barrier which may have to be left against the waterlogged workings.

(xi) Check for old shafts/boreholes and their depth vis-à-vis their relation with the present workings for leaving necessary thickness of barrier/parting and/or taking other precautions.

(xii) Check the gradient of approach and nature of the seam to leave a safe thickness of barrier.

(xiii) Provide dams with bulkhead doors filled in them in the galleries intended to be advanced toward the waterlogged workings.

(xiv) Use waterproof electrical gears and compressed air equipments in connection with the machines to be utilised.

(xv) Provide protection to valuable macheries by positioning them outbye of the dams.

(xvi) While workings are being advanced towards the water logged workings, the make of water shall be measured by placing V – notches at the strategic point. The nearness to the water bodies is indicated by the increase in the percolation of water.

(xvii) For the same purpose air samples should be drawn from the advance boreholes and any increase in the CH_4 % and H_2S % will indicate nearness to the water logged workings.

(xviii) If the make of water when tapped is likely to be large and also on a precaution against chance connection provide the following :-

(a) A warning system for withdrawl of persons.

(b) A safe escape route by which the persons can escape to safety without being hindered by the flow of water along the route. Infact there should be no flow of water along this route.

(c) A set of standing order for withdrawl by persons with arrangements for periodical mock rehearsal.

(xix) The manager shall keep himself throughly apprised with the conditions of the workings everyday and shall personally inspect the concerned workings as often as practicable or considered necessary .

Mine Ventilation

Q. What is Basic Effective temperature ?

A. It is defined as the temperature of saturated still air which gives the same sensation of warmth to a worker as given by the normal mine climatic condition of temperature, himidity and velocity. Above 28°c BET, the work output decreases, men become more irritable and prone to range of heat disorders.Effective temperature at working faces in Indian coal mines is due to high isotherm and high virgin rock temperature affecting the labour productivity .

Q. What is Reynold's number ?

A. It is a number which indicates the nature of flow of ventilation current. It is a expressed as ;

$$\boxed{K = \frac{evD}{\eta}}$$

where;
v = critical velicity
e = density of air
η = viscosity of air
D = dia. of x - sextion

When k <2000 , flow is steady
When k is 2000 - 3000 , flow is unstable
When k > 3000 , flow is turbulent.

Q. What is shanky's diagram ?

A. It is a diagram which indicates the energy in any system, right from the input to output.

In ventilation, it shows the leakages of air current right from the surface to the working faces .

Q. What is V.E.Q. ?

A. Ventilation efficiency quotient is defined as the ratio of quantity of air reaching the last ventilation connection in the district and the quantity of air reaching the ventilation district.

$$\boxed{V.E.Q. = \frac{Q_2}{Q_1} \times 100}$$

where Q_1 = quantity of air reaching the district
Q_2 = quantity of air at last ventilation connection

In general, VEQ not less than 70 % .
However this depends upon no^s of stoppings .

Q. How much quantity of air is required for dilution of blasting fumes ?

A. The quantity of ventilation current required for dilution of blasting fumes is given by

$$\boxed{Q = \frac{100\,A.B.}{C \times t}} \quad m^3/min$$

Where
A = mass of explosives blasted (kg)
B = volume of noxious gas produced (m^3/kg of explosion)
C = Max. concentration of gas(% by volume)
T = time of ventilation required to dilute the gas to the permissible concentration (min)

Q. Where is the composition of atmospheric air ?

A. The composition of dry atmospheric air is given below:-

Components	**% by volume**	**% by mass**
1. oxygen (O_2)	20.95	23.15
2. carbondioxide(co_2)	0.03	0.046
3. Nitrogen (N_2)	78.09	75.52
4. Argon and other rare inert gases like kr, xe,etc	0.93	1.284
Total	100.00	100.00

Q. State Bernoulli's theorem.

A. For incompressible and non-viscious fluid, flowing in streamline motion , the sum of its kinetic energy , potential energy and pressure energy remains constant at all cross-sections .

$$1/2mv^2 + mgh + pv = const .$$

Q. What is Brownian motion ?

A. It is defined as the random motion of submicroscopic particles (below 1 cm in size) imparted by gas molecules bombarding on them. As the particle size increases, the effect of Brownian motion becomes negligible as compared to gravitional setting.

Q. What is Boundary layer ?

A. When a viscous fluid flows past a solid boundary, its velocity at the contact with the boundary is reduced to that of the the boundary. The velocity increases as we proceed away from the boundary until beyond a certain layer adjacent to the boundary. This layer is known as boundary layer.

Q. What is equivalent orifice ?

A. It is defined as the area of the orifice in a thin plate which offers the same resistance to airflow as the mine.

$$\boxed{A = \frac{1.29\,Q}{\sqrt{P}} = \frac{1.29}{\sqrt{R}}}$$

Where;

A= area of orifice (m^2)
P= pressure causing air flow
R= resistence of mine
Q=Quantity of air

Q. What is Euler's equation ?

A. Euler's equation gives thetheoritical or input head generated by the impeller of Centrifugal fan. It is expressed as:-

$$\boxed{Hi = \frac{P}{Q.e.g}} \text{ m}$$

where:-

H= input head
P= Power input to the impeller vanes (Watt)
Q= quantity of air flowing (m^3/sec) per unit time
e= density of air (Kg/m^3)
g= accelaeration due to gravity (m/s2)

Q. Define the following terms :-
(a) Air H.P. (b) Manometric efficiency
(c) Fan efficiency (d) Overall efficiency

A. (a) Air H.P. :- It is defined by the following expression

$$\boxed{\text{Air HP} = \quad \frac{PQ}{75} \quad \frac{RQ^3}{75}}$$

Where:

P = Pressure of air (N/m^2)
Q = Quality of air (m^3/s)
R = Resistance of mine($k\mu$)

(b) Monometric efficiency,

$$\eta_m = \frac{\text{Actual depression}}{\text{Theorytical depression}}$$

$$\frac{\text{Produced water gauge of fan}}{\text{Designed water gauge of fan at given velocity}}$$

(c) Fan efficiency $= \dfrac{\text{Air H.P}}{\text{BHP of fan}}$

(d) Overall efficiency $= \dfrac{\text{output}}{\text{Input to motor}}$

$$= \frac{\text{Air H.P}}{\sqrt{3}\ VI\ \cos\phi}$$

Q. What is self- closing door ?

A. A self- closing door is one in which door frame is installed at an angle of 10° with the vertical so that the doors close by its own weight. These doors may be controlled by photo-electric relays.

Q. How current of air can be reversed in a MMV?

A. Current of air can be reversed in a MMV by the following arrangement :-

(i) By re-arranging the set of doors.
(ii) By changing the angle of blades.
(iii) By reversing the drive belt/ropes and rotation of electric motor.

Q. What are the dangers associated with reversal of MMV. ?

A. Following are dangers associated with reversal of MMV

(i) An explosion may be caused as the products of combustion may be pushed back.

(ii) The Survivors' if any, will base their strategy for escape from the mine by the existing intake airway. In such an event, if reversal occurs,they will be killed by P.O.C. pushed back.

(iii) The ventilation doors between main intake and return or at any place are designed normally to open against the pressure of the intake air. If the ventilation door will open up and then the air will be short circuiting. Then the purpose for which reversal is done, that will not be served.

EXPLOSIVE AND BLASTING

Q. What is blastability ?

A. It is defined as the ratio of compressive strength of rock and the tensile strength of rock .

$$\boxed{B = \sigma_c/\sigma_t}$$

Q. What is drillability ?

A. Drillability of rocks is defined as the rate at which it can be deilled or the time taken to drill a unit depth of hole. It depends on shape, size and material of the bit, number of cutting edges, applied thrust, rotational speed and properties of rocks.

Q. What is Peak Particle velocity ?

A. It is defined as the largest value of the vector sum of the traverse, longitudinal and vertical components of particle velocity. It is a criteria for evaluating blast vibration damage. In elastic wave (rock-mass) propagation. Particle velocity strain . As the damage to any structure is caused by differential displacement or strain, use of particle velocity is acceptable as the most appropriate parameter of blasting vibration Mathematically :

$$\boxed{V = K\left(\frac{D^{2/3}}{Q}\right)^b}$$

where
V = peak particle velocity (mm/sec)
K= site constant
D =distance between blast site and instrument station
Q = maximum charge per delay (kg)
b = slope of best fit of V vs $\left(\frac{D^{2/3}}{Q}\right)$ plot on a log-log scale

Q. What are factors affecting peak particle velocity ?

A. Major factors affecting peak particle velocity of ground vibrations are:

1. Charge weight per delay :- Intensity of vibration increases with charge weight per delay.

2. Delay interval : It is so arranged between rows that the wave fronts emanating from corresponding charges are seperated avoiding superimposition.

3. Burden and spacing.

4. Direction of initiation – seismic and air – overpressure amplitude perpendicular to direction of blast is larger than parallel to blast.

5. Charge confinement.

6. Distance of charge from the point of abservation.

7. Geological and physical properties of rocks that transmit the vibrations.

Q. What is resonance ? How it is created ?

A. Resonance is a state in which the structure absorbs most of the vibration energy progressively becoming deformed with time, until plastic deformation occurs . When the low frequency ground vibrations coincide with the natural frequency of the structure, resonance is created and the effect is amplied. Therefore, even low peak particle velocity of ground vibration at the natural frequency of a structure is harmful to structures.Hence it is important to consider natural frequencies of relevent structures while gauging the damage potential of ground vibrations. At resonance, the structure oscillates for a longer period resulting in structural damage.

Q. What is structural response ?

A. Vibration measured within or on a structure is normally termed as structural response.

Q. What is dominant excitation frequency ?

A. It is the frequency of vibration or wave having maximum vibration energy.

Q. What is scaled distance ?

A. When blasting is done on surface and measurements are taken on the surface or the blasting is done underground and measurements are taken underground, square root scaled distance is used which is defined as the actual distance between blast site and point of observation divided by the square root of the charge weight.

$$\boxed{S = \frac{D}{\sqrt{Q}}} \quad (\mathrm{m}/\sqrt{\mathrm{kg}})$$

On the other hand, if blasting is done on the surface and measurements are taken underground, the cube root scaled distance is used which is defined as the actual distance divided by the cube root of the charge weight.

$$\boxed{S = \frac{D}{(Q)^{1/3}}} \quad (\mathrm{m}/\mathrm{kg}^{1/3})$$

Q. What is zone of disturbance ?

A. Excessively high ground vibrations from underground blasting alone or coupled with increased stress due to openings created by extraction of coal may cause damage to roof rock and may affect the stability of roof bolts and mine supports and cause ventilation stoppage. It has been observed that in conventional methods of blasting in mining and construction projects, a peak particle velocity of 100mm/sec is a safe value for the stability of the coal mine roof and pillars from underground blasting . Hence the area of underground workings experiencing a vibration of 100mm/s or more is treated as zone of disturbance.

Q. What is danger zone ?

A. As per provision of regulation 170 (1a) (b). of CMR,1957, danger zone is an area falling a radius of 300 metres from the place of firing. It may be 500m or even more as recommended by DGMS vide their circular (Tech) no.8 of 1982.

Q. What is air – over pressure ? What are the reasons. How it is produced ? What are control measures ?

A. Air – over pressure :- It is an atmospheric pressure wave consisting of wide range of frequencies audible as well as inaudible.

Reasons :-

(i) Direct rock displacement at the face
(ii) Vibrating ground
(iii) Gases escaping from the detonating explosives.
(iv) Gases venting out through the stemming.

Production of air over- pressure :-

1. By bench-blast: Air – over pressure is produced by bench blasting which is given by

$$\boxed{Po = 160 - 20 \log \left(\frac{D}{Q^{1/3}}\right)}$$

Where symbols have their usual meaning.

2. By detonating cord :- Covered cord produces less air – over pressure.

3. By secondary blast :- plasting shooting produces more air – over pressure.

Permissible limit :- As per U.S.B.M., it should be less than 150 dB.

150 dB : cracks may develop

170 dB : most cracking

180 dB : structural damage

Control measures :-

- Limiting maximum charge per delay.
- Covering of detonating cord by soil.
- Delay interval so arranged that rate of blast propagation is less than sonic velocity of air.
- Shock tube initiation system.

Q. What are the precautions required to be taken while blasting in hot strata ?

A. Such precautions are:-

1. Only slurry and emulsion explosives shall be used

2. Blasting shall be done with detonating fuse down the hole .

3. Temperature inside the blast holes shall be measured (before filling with water) and if the temperatures exceeds 80°c, in any hole, such hole shall not be charged. Records of measurements of temperature in such hole shall be maintained in a bound paged book.

4. All blast holes shall be kept filled with water. When any hole is traversed by cracks or fissures, such hole shall not be charged unless it is lined with an asbestos pipe and the hole filled with water . In addition, bentonite should be used for sealing any cracks at the bottom of the holes.

5. Detonating fuse shall not be laid on hot ground without taking suitable precautions which will prevent it from coming in contact with hot strata.

6. The charging and firing of the holes in any one round shall be completed within 2 hours.

7. Blasting operations shall be carried out under the supervision of an assistant manager.

Q. What is secondary blasting ? What are the techniques of secondary blasting ?

A. It is a method of rock blasting in which oversize boulders are broken .Secondary blasting to break oversize boulders is achieved either by POP shooting or plaster shooting.

(i) Pop shooting :- For Pop shooting in small boulders, a hole is drilled in the centre, the length being a little in excess of half the thickness of boulder. For larger boulders, several holes may be necessary. One 25mm x 200 mm, cartridge of powergel 801 for every $2m^3$ of rock is used.

(ii) Plaster shooting :- It requires no drilling. It is a quick and efficient method of breaking boulders and elimates the use of drilling equipment. The charge is laid on the boilder and covered with a shovelful of plastic clay. The average charge ratio is 600gm for every metre thickness of boulder.

Q. What are the advantages and disadvantages of inclined holes ?

A. As the inclination of the bench face is increased, the free face area becomes more and hence with the increase in the inclination of the bench more explosive energy is reflected back after the shock wave has reached the free face. As a result, grater energy will be available for fragmention of toe.
The following are the **advantages** of inlined holes.

(i) Better utilisation of explosive energy and better fragmentation.

(ii) Less back break.

(iii) Easy toe breaking.

(iv) Less drill meterage required.

(v) High fragmentation results in cost reduction on accont of loading, transport and crushing.

Disadvantages are :-

(i) Difficulty in drilling
(ii) Strain on the drill

It is claimed that per 1° of inclination, 10 %, explosive energy is saved .

Q. What is fly rock ? What causes fly rocks and how it is controlled ?

A. Flyrock is a rock which is unexpectedly propelled from a blast site well beyond normal expectations.It occurs when explosive energy in the form of gas expansion energy is vented into the atmosphere and propels the rock infront of it . All blasts more or less produces flyrock. Flyrocks also increases airblast. Due to crater effect, it can travel on any direction and throw of flyrock depends upon local geological conditions and blast parameters.

Causes of flyrock :-

(i) Poor blast design like use of large diameter blast holes for small benches, variation in burden due to overbreak or toe, drilling deviation, inadequate burden and too close spacing.

(ii) Improper charging and firing – High specific charge, concentration of free flowing slurries at the bottom of holes, inadequate length of stemming column, improper size of stemming material, top initiation and simultaneous firing.

(iii) Presence of major geological discontinuties such as faults, weak planes, cracks, bedding planes, mud seams, open fractures, open joints etc.

(iv) Poor blast site control.

(v) Presence of loose stones at the blast site.

(vi) Presence of water in the blast holes.

(vii) Improper profile of bench.

(viii) Less cohesion and adhesion of rock bed.

(ix) Speed and direction of wind.

(x) Presence of uncharged holes in the vicinity of charged holes.

Control of flyrocks :-

(i) Accuracy in the interpretation of the geology of the area.

(ii) Proper blast design according to the site conditions.

(iii) Monitoring of loading of explosives.

(iv) Deck charging in weak rocks in betweeen hard rocks.
(v) Muffle blasting in populated areas.

(vi) Ensuring that with the stemming material boulders do not fall into the hole. Such boulders act as missiles and are thrown over very long distances.

(vii) While charging explosive in watery holes, it is to be ensured that it settles down and does not float.

Q. What are likely causes of mis fire? How it is detected and relieved in multi – shot face blasting u/g ?

A. Likely causes of mis–fires are:

(i) wrong connection
(ii) faulty exploder
(iii) faulty detonator
(iv) faulty explosive
(v) current leakage
(vi) short circuiting due to hard stemming/ poor insulation.
(vii) Poor crimp

Detection and relieving of misfire in multi – shot face underground:-

After smoke and fumes are cleared, the shot – firer inspects the face for any mis-fire or shocket. This becomes evident from the face profile and left out detonators wires. As soon as this is detected, the precautions as under regulation 177 of CMR are taken.

These are:

(a) Drilling of relieving hole at a distance not less than 30 cm.

(b) This hole is charged and blasted.

(c) Blasted material shall be searched for misfire cartridge.

(d) If not, the material shall be loaded in a tub with special marking.

(e) This material shall be searched on surface.

(f) After availability of cartridge it shall be destroyed safely.

(g) A report has to be written in a bound paged book kept for this purpose.

(h) If the operation cannot be completed in the shift, the shot – firer shall give the charge of misfire hole to the shot firer of the next shift.

Q. What are sleeping holes ? What are the precautions required to be taken for such holes ? What are dangers of sleeping holes ?

A. In highly mechanised o/c mines huge quantity of explosive is blasted at a time. This is done once in a week generally. Drilling and charging goes on other six days . If a hole is charged but not blasted in the same day, it is known as sleeping hole. Such holes are dangerous, hence special precautions are necessary for safety. Such precautions are:

(i) No smoking or open sparking or welding to be done within 30 m.

(ii) The gap between hole under drilling and sleeping hole shall be at least two rows of holes.

(iii) Area of charged holes shall be marked by red flags in day time and red lights in the night.

(iv) Sleeping holes shall be kept stemmed. Only short length of detonating chord is exposed.

(v) The bore hole and collar area shall be covered with soft stemming material, so that there is no chance of contact with static electicity or lightening from sky.

(vi) Loading of holes may be done everyday but electric connection will be done only on the day of firing.

(vii)Only detonating fuse will be connected but detonation will be connected only on the day of firing.

(viii)Maximum sleeping period is 15 days, 50 days in case of dragling benches.

(ix) A record of date of charging has to be maintained by blasting officer. Manager shall monitor the same on daily basis and agent will check periodically.

(x)When only two or three days are left, the manager will inform the agent who will co-ordinate the work.

Dangers of sleeping holes :-

(i) Premature detonation of explosive charge.
(iii)Chances of explosion if fire nearby.
(iv) Chances of misfire specially in watery holes
(v) Sparks leading to explosion through electrostatic and electromagnetic induction.

Q. What is the slurry and emulsion explosive ?

A. Slurry explosives :- It is a mixture of oxidiser and water. This chemical mixture is thickened with Guar Gum and Cross linked. The thickener enables to prevent leaching of the blast holes. This makes slurries or water gels excellent water resistant.

Slurry composition (by weigh %) :-

(i) Oxidiser ($NaNo_3$, NH_4NO_3): 50- 80 %

(ii) Combustible agent (liquid combustibles): 1- 10 %

(iii) Water sensitizer (Aluminium and Nitro compounds) : 5 – 30 %

(iv) Sarfactant: 1 – 5 % (not always)

(v) Stablizer: 0.1 – 5 %

(vi) Air bubbles (Gas generating and Foaming agent)

Emulsion explosive :- It is a mixture of oxidiser and fuel. It also contains water but does not contain gums and geling compounds.

Composition of emulsions :-

1. NH_4NO_3 : 60 – 70 %
2. $NaNO_3$ / $Ca(NO_3)_2$: 0 – 20 %
3. Fuel oil : 2 – 6 %
4. Aluminium : 1 – 3 %
5. TNT and water : varies

The above contents are hot mixted at 50 % and a suitable gassing agent is added to control density.

Q. What is blasting – off – solid ? What is safety in B.O,S. ? What are the conditions imposed by D.G.M.S. in B.O.S. ?

A. It is a technique of full face firing without precutting by coal cutting machines . Extra free face is created for each shot by using millisecond non-incendive delay detonators with ultrasafe P_5 explosive in a controlled sequence of Pre- determined Pattern of shot – holes loaded with calculated charge of explosives in different holes.

Safety in B.O.S. :-

(a) Cooling agent in P_5 explosive which brings down the temperature of expanding gases to safe limit and prevents ignition under any adverse condition.

(b) Non – incendive delay detonators eliminating dangers of gas/ coal dust explosion and roof / side damage by vibration.

Restrictions imposed by DGMS.

(i) Quantity in air – 284 m^3 / min in Ist degree mine
300 – 400 m^3 / min in IInd III rd degree.

(ii) Water spraying upto 90 m from face of blasting.

(iii) Coursing of air – 3m from face for degree II and III

(iv) Maximum charge / hole – 1 kg for Ist degree gassy mine.
-0.565 Kg for II & III degree gassy mine

(v) Delay interval between Ist shot and last shot :-
150 millisecend for Ist Degree
100 millisecond for II & III degree

(vi) Gap between two shot–holes – not less than 60 cm

Q. What are dangers of solid blasting in coal mines and the precautions required to be taken against these dangers ?

A. Enumerated below are the dangers and precauties in B.O.S. :-

Dangers

1. Chances of blown out shots.
2. Chances of flying rocks to go to a longer distance
3. Chances of misfire
4. High shattering effect and vibration causing dislodgement of face supports and damage of roof
5. Chances of inflammation, explosion and fire
6. More formation of dust
7. Scattering of blasted coal damaging brattices and other face installation.

Precautions:

1. Permission has to be taken from DGMS
2. To get the blast design prepared by experts
3. Use of P_5 explosives only
4. Use of delay detonators of short and limited delay.
5. Adequate ventilation at face.
6. Arrangement of dust suppression with regard to water pressure, water quantity and organisational set up.
7. Mining sirdar shall fire the shorts himsrlf.
8. Drilling, charging etc under the supervision of mining sirdar.
9. Frequent inspection by superior official.
10. Support of 10 m of freshly exposed roof by SSR with approved type of support.

Q. Why a coal face is required to be under cut, over cut or side cut and length of shot hole is required to be at least 15 cm, less than the depth of cut ?

A. Cut is necessary to have a second free face so that it does not become solid blasting. Because, the solid blasting has the following **dangers**: –

(i) Chances of Blown out shots
(ii) Throwing of fly rocks to a longer distance
(iii) Chances of misfire
(iv) Chance of inflammation and explosion
(v) Blowing out of support
(vi) Vibration and shattering effect etc.

If the length of shot – holes is not less than the depth of cut, it will become solid blasting. It is done for the following purpose :-

(i) The force of blasting will pull down the coal mass due to the second free face.
(ii) Chances of shock reflection does not occur.
(iii) Energy being fully utilised for blasting, no major balance remains to create dangers.

Q. What are safety features of carrick delay detonators ?

A. Safety features are :-

(a) Antistatic sleeve
(b) Thick copper tube
(c) Five cores in lead tube containing small quantity of delay element equally distributed.

Q. What is Cap Sensitive and non- capsensitive explosive?

A. Cap-sensitive Explosives :- Those explosives which are sensitive to detonators are known as cap.-sensitive, explosives.
All booster/ primer are cap- sensitive because it is sensitive to detonators. All permitted explosives are cap- sensitive.

Non cap-sensitive explosives :- Those explosives which are not sensitive to detonator but sensitive booster are called non cap- sensitive explosives.
e.g. Powergel, Energel, supergel etc.

Q. What is ultra- safe explosive ?

A. Explosives, which contain sufficient cooling agent to bring down the temperature of expanding gases to a safe limit (well below the ignition temperature) and prevent agnition of gas and coal dust under any adverse condition, are known as ultra safe explosives. E.g. P_5 explosives.

Q. What is controlled blasting ?

A. Controlled blasting is a method of rock blasting where the risk for damage to surrounding structures and installations are eliminated by planned drilling and charging procedures to enable vibration control and by taking all measures such as covering for protection against flyrock.

Q. What is the purpose of controlled blasting ? What are the techniques of controlled blasting ?

A. Controlled blasting is done to:
(i) Reduce overbreak
(ii) Minimise fracturing of rock at the bottom of an excavation and
(iii) Control flyrocks.
In controlled blasting, blast dimension is achieved by trial and error method.

Techniques of control blasting :

(a) Line drilling :- In this method, rows of closely spaced holes are drilled along final line of extraction and are left unchanged. Adjacent blast holes are loaded lightly and closely spaced than other bore holes.

Dia of holes – 50 to 75 mm
Spacing – 2- 4D where D= dia of holes
Depth – maximum 10m

Advantages :-

(i) Reflection of shock waves
(ii) Reduction in shattering effect.

Disadvantages :-

(i) High drilling cost
(ii) Difficult to maintain accuracy.

(b) **Pre-splitting :-** In this method, artificial discontinuity is created in between blasted area and the area to be protected. Single row of holes are drilled at final excavation line with dia 50-100mm, spacing 6-12 times dia and maximum depth upto 15m. Holes are charged with high density explosives and blasted by detonating cord with in-hole delay arrangement. Bottom portion of holes are charged heavily. Stemming is optional.

(iii) **Cushion blasting :-**

- Drilling of row of 50-100mm dia bore holes along final line of extraction.
- Loading with light well distributed charge
- Burden > spacing
- Loading similar to pre-splitting
- Maximum depth – 30 m

(iv) Smooth blasting:- It is done in u/g

- At the perimeter of tunnel or drift, closely spaced holes with burden and spacing ratio = 1.5 : 1
- Loading with well distributed change
- Spacers are used
- Back of the bore-holes are heavily loaded
- Stemming must.

Q. What is sympathetic detonation of explosives ?

A. It is a process of inition of an explosive charge (receptor) without a priming device by detonation of another charge (donor) in the neighbourhood. The maximum distance at which detonation is transmitted between two explosives when kept in line is generally estimated by a flash-over test. The transmission mechanism is complex and is influenced by various parameters like intensity and directioin of shock wave hot reaction products, flying of metallic parts in the casing etc.

Indian Electricity Rules

Q. Define the following terms :

A.1. Flexible cable :- A cable consisting of one or more cores each formed of a group of wires, the diameter and the physical properties of the wires and the insulating material being such as to afford flexibility.

2. Circuit breaker :- A device which is capable of making and breaking the circuit under all conditions, and unless otherwise specified, so designed as to break the current automatically under abnormal conditions.

3. Danger :- means danger to health or danger to life or any part of body from shock, burn or other injury to persons or property, or from fire or explosion, attendant upon the generation, transmission, transformation, conversion, distribution or use of energy

4. Flameproof enclosure :- means an enclosure for electrical machinery or apparatus that will withstand, when the covers or other access doors are properly secured, an internal explosion of the inflammable gas or vapour which may enter or originate inside the enclosure, without suffering damage and without communicating the internal flammation (or explosion) to the external inflammable gas or vapour in which it is designed to be used, through any joints or other structural openings in the enclosures.

5. Intrinsically safe :- as applied to apparatus or associated circuits shall denote that any sparking that may occur in normal workings is incapable of causing explosion of inflammable gas or vapour.

6. Portable apparatus :- means an apparatus which is so designed as to be capable of being moved while in operation. eg - C.C.M., Drill, SDL, LHD, Electric shovel etc.

7. Transportable aparatus :- Means an apparatus which is operated as to be capable of being moved readily from one place to another.
e.g. A Face Conveyor, Auxillary Fan etc.

8. Hand held Portable apparatus :- Means an apparatus which is so designed as to be capable of being held in the hands and moved while connected to a supply of electricity.

9. Open Sparking :- Means spaking which owing to the lack of adequate provisions for preventing the ignition of inflammable gas extenal to the apparatus would ignite such inflammable gas.

10. Voltage :- Means the diference of electric potential between any two conductors or between any part of either conductor and the earth as measured by suitable voltmeter in volts.

Low voltage - not exceeding 250V
Medium volatage - not exceeding 650V
High voltage - not exceeding 33,000V
Extra high Voltage - exceeding 33,000V

Q. What is the purpose of earthing ?

A. The purpose of earthing is to eliminate danger to persons due to electric shock, if they come in contact with some parts of a machine or apparatus, which is normally dead but may get electrically charged and become live due to failure of insulation or contact with live parts. It gives protection against shock in case of non-carrying conductor takes current.

Actually earthing alone is not a complete safeguard, and it is important that, upon the occurance of an earth fault in cables or apparatus, the faulty circuit shall be isolated automatically and with the least possible delay that can be ensured by means of automatic leakage trips.

Q. Neutral point of Secondary winding of a transformer is earthed – Why ?

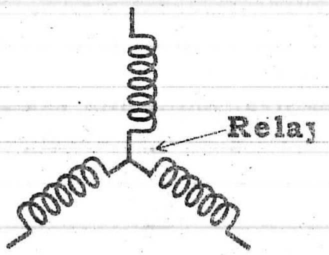
A. The neutral point of secondary transformer winding of a transformer is earthed. The purpose of earthing is to prevent that side from being charged to a high potential if a fault develops between low tension and high tension winding.

Q. What are the various methods of earthing ? What are their relative advantages and disadvantages ?

A. Various methods of earthing are :

(a) Insulated neutral system
(b) Earthed neutral syatem
(c) Restricted earthed neutral system

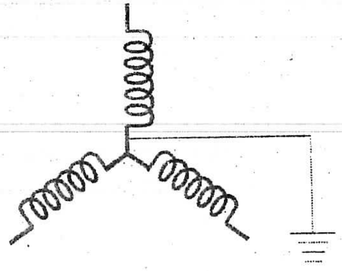
(a) Insulated neutral system :
In this system, an eletrical relay is connected between neutral of a transformer's secondary winding and one of its phase.



In this system, there is no chance of leakage but there is chance of electric shock.

(b) Earthed neutral syatem:

In this system the neutral of the transformer' secondary is connected to earth directly. This is also called direct neutral earthing system or solidly grounded earthing system.



Advantage :

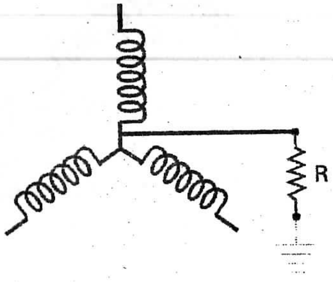
In case of any earth fault, there will be heavy leakage of currents and tripping will definitely occur.

Disadvantages :

(I) Very high magnitude of earth fault current at the fault point and consequent risk of fire and explosion.
(iii) Dangerous electrical shock because of high potential difference between equipment casing and the earth at the time of an earth fault.

(c) Restricted earth neutral system:

In this system, the neutral of the transformer's secondary is connected to earth through a resistor fitted between the neutral point and the earth point. This is also called resistance grounding system.



Advantages :

Earth fault current will be restricted to very low value and consequently chances of explosion and fire reduces.

Q. What is power factor ? How it is improved ? What are the advantage of improvement in power factor ?

A. Power factor :- It is defined as the ratio of actual power and apparent power.

$$P.F. = \frac{\text{Actual Power}}{\text{Apparent Power}}$$

$$\cos\phi = \frac{V.I.\ \cos\phi}{V.I.} = \frac{P\ actual}{V.I.}$$

$$P\ actual = V.I.\ \cos\phi$$

For 3 phase, $P = \sqrt{3}\,(V.I.\ \cos\phi)$

Where cosϕ is the power factor and ϕ is the phase diff between current and voltage.

Improvement of Power factor :

Power factor can be improved by :-

(i) using capacitors
(ii) using synchronous motors

Capacitors are preferred because these are available in various suitable ratings and are more easily installed either in bulk at the point of colliery supply or to connect individual induction motors by connecting capacitors at their terminals. These are cheaper.

Advantages of improved power factor :-

i) Substantial reduction in KVA demand
ii) Considerable reduction in transformers and line losses.
iii) Improved voltage regulation/reduction in voltage drops in motors.
iv) Reduction in reactive power demand from source
v) Release of circuit load capacity
vi) Reduction of voltage fluacuations and circuit reactance.

Q. What is load factor ? How it is improved?

A. Load factor is defined as the ratio of the average power to the maximum demand. It is the ratio of actual consumption of KVAH and the maximum, KVAH for which the plant has been designed.

In general,

$$\text{Load factor} = \frac{\text{Average Power}}{\text{Max-demand}} \quad \text{per year or per month or per day.}$$

Since the tariff consists of two components i.e.

(a) Maximum demand ; and
(b) KWH consumed, the tariff increases because of reduced load factor.

Improvements of Load factor :-

(i) Plant design should be as need with a reserve of 10 to 15 %
(ii) Operation of machine at full load.
(iii) Staggering of operation
(iv) Maintenance of machines
(v) Energy auditing.

Q. What is capacity factor or plant factor ?

A. This factor relates specifically to a generating plant unlike load factor which may relate either to generating or receiving equipment for the whole station. It is defined as the ratio of the average load to the rated capacity of the power plant.

$$\text{Plant factor} = \frac{\text{average load}}{\text{Rated capacity of plant}} = \frac{\text{av.demand on station}}{\text{max. installed capacity of station}}$$

It may be of interest to note that if the maximum load corresponds exactly to the plant ratings, then load factor and plant factor will be identical.

Q. Why an electrical circuit is made intrinsically safe ? What is an intrinsically safe circuit ? What are the requirement of intrinsic safety ?

A. Electrical equipments are to be designed with great care due to sparking caused by the discharge of energy from the reactive parts of the circuit at the moment when the circuit is broken. Therefore, in most electric circuits used in mines, the energy which causes the spark is stored in the magnetic fields created by electromagnetic apparatus.

Sometimes a single small spark is capable of igniting air firedamp mixture. Special types of ckts can be designed so that the discharge of reactive energy is controlled, and does not produce an incentive spark when the circuit is broken. Hence to control the reactive energy, an electrical circuit is made intrinsically safe.

Intrinsically safe circuit :

Any electrical circuit which is so designed that it is incapable of producing a spark or flash which will ignite air- firedamp mixture under any condition likely to arise in mines is known as intrinsically safe circuit. Intrinsic safety can be obtained in circuits with a low power consumption i.e. both the voltage of the system and the current flowing in the circuit must be limited. In practice, intrinsic safety is confined to circuits for signalling, telephone, remote control and monitoring.

Requirement of intrinsic safety :

(i) The power obtainable from the source of supply must be limited so that the reactive energy in the circuit does not any time exceed the limit of safety.
(ii) There must be a means of absorbing the reactive energy which is released when the circuit is broken.

Q. What is FLP enclosure ? What is difference between intriscally safe circuit and FLP enclosure ?

A. FIP enclosure is an enclosure with specific design so that, there may be explosion of gas inside, the hot gas may come out, even flame may come out but it is so cooled down that it is not capable of igniting the outside explosive mixture.

Design commonly adopted are :-

Flange- external/internal
Bolts- shrouding

Gap- of specific dimension i.e.,
Air- break equipment- 0.5mm(0.02 ")
Oil- break equipment- 0.15mm(0.006 ")

Difference between I.S. apparatus and FLP enclosure :

I.S. apparatus

(i) For smaller electrical equipment and circuit
(ii) Voltage is within 30 Volt.
(iii) Flowing current is within 1 amp.
(iv) Explosion is prevented by de-energising sparks.
(v) Mostly for auxiliary equipment.
Example- Bell, Telephone etc.
(vi) For an electrical apparatus

FLP enclosure

(i) For bigger electrical equipment and non- electical equipment.
(ii) Voltage may be anything .
(iii) Flowing current may be anything.
(iv) Explosion may occur but the exit gas is cooled down.
(v) For production and other big equipment.
(vi) For both electrical and non- electical equipment.

Q. What is glare ? How it is minimised ?

A. Glare is defined as any brightness within the visual field of such a character as to cause discomfort, interference with vision or eye causing fatigue.

In order to minimise the glare, the light should be so arranged that they do not come directly in the field of vision under normal working condition i.e. the light source should be shielded from direct view as far as possible.

Glare is bright source in dark background. To minimise glare, a small source of light at closer distance should be used to get uniform illimination instead of placing brighter source at wider distance.

Q. What are the statutary provisions rergarding use of flexible cable for portable or transportable apparatus ?

A. The provisions are as follows :-

1. It shall be of two core or multi-core and shall be covered with insulating material efficiently protected from mechanical injury. Even if the mechanical protection components is used as earth conductor, it must have a separate earth conducting core.

2. Such cables shall be connected to portable or transportable apparatus by properly constructed connectors. In case of high voltage machine, bolted type connectors shall be used.

3. Where the flexible cable is connected to the main cable, a switch shall be provided so that electricity can be completely cutoff.

4. The fflexible cable shall be examined periodically by authorised persons. In u/g mines, it shall be examined atleast once in each shift by such person. If it is found to be defective, it shall forthwith be replaced by a goodone.

5. If the voltage of the circuit exceeds low voltage, then flexible cable shall be provided with flexible metallic covering/screening or pliable armouring. However, this provision is not applicable for o/c mines if reeling and unreeling of such cable is associated with the design.

6. All flexible metallic screening or armouring shall confirm to the earthing provision laid under rule 122(d). Provided that in case of seperately screened flexible cables, the conductance of each such screen shall not be less than 25% of any power conductor and combined conductance of all such screens shall not be less than 0.15 cm^2 copper conductor.

7. Maximum permissible length of flexible cable shall not be more than 100 m in any mine.

For CCM or L/W face – 200 m
For electrically operated HEMM in OCP- 300m

8. They shall be efficiently supported and protected from mechanical injury and shall not be used for other mechinaries than portable and transportable machines.

9. When flexible cabbles are used, they shall be detached or otherwise isolated from the source of supply when not in use and arrangements shall be made to prevent energising such cables by unauthorised persons.

Q. What are the statutory provision regarding disconnection of supply ?

A. The provision are as follows :-

1. Properly constructed switchgear for disconnecting the supply of energy to a mine shall be provided at a point approved by the inspector. During the time any cable supplying energy to the mine from the aforesaid switchgear is live, person authorised to operate the said switchgear shall be available within easy reach thereof. In case of II & III gassy seam, the MMV operated by electricity shall be interlocked with the switchgear so as to automatically disconnect the power supply in the event of stoppage of main mevhanical ventilator (MMV).

2. An appropriate apparatus suitably placed, shall be provided for disconnecting the supply from every part of a system, if necessary.

3. The above apparatus shall be so arranged as to disconnect automatically from the supply any section of the system subjected to a fault as considered necessary by Inspector.

4. Every motor shall be controlled by switchgear which shall be so arranged as to disconnect the supply from the motor and from all apparatus connected thereto. Such switchgear shall be so placed as to be easily operated by an authorised person.

5. The motor shall be controlled by a switchgear to disconnect automatically the supply in the event of condition of over-current, over-voltage and single phasing wherever required by Inspector.

6. When not in use, flexible cable shall be isolated from source of supply.

7. When lamps are being charged, the supply shall be disconnected.

Q. What are the statutory provisions regarding voltage limits ?

A. Energy shall be not transmitted into a mine at a voltage exceeding 11 kv and shall not be used therein at a voltage exceeding 6.6 kv.

However, this shall be subjected to following limitations :–

	Maximum voltage
(a) Hand- held portable apparatus-	125 V
(b) Electric lighting	
(i) u/g (phase to phase) -	125 V
(ii) o/c mines and surface of mines (phase to phase)	250 V Neutral point shall be connected with earth
(c) Portable hand lamps u/g -	30 V
(d) circuits for remote control or inter-locking of apparatus	30 V
(e) in fixed plants if bolt type plug is used	650 V

Rescue and Recovery

Q. What is rescue Tracing ? What is the purpose of it ? How it differs from ventilation plan ?

A. This is the tracing of underground plan showing the working of mine and other details .There shall be kept in all u/g mines morev than 3 legible tracings of the working of the mine. This shall be updated within 3 months.

Such tracings shall show :

- The system of ventilation
- The general direction of air flow with quantity of air passing through air measurement stations.
- All ventilation devices, stoppings, air crossings, door etc
- Boster fans
- Firedams, waterdams with dimensions and other particulars of construction
- Fire fighting stations
- Telephones
- First aid stations
- Pumping stations
- Stores of inflamables
- Reserve stations
- Haulage roadways and travelling roadways.

The purpose of rescue tracing is to help the rescue team to conduct their operations.

One copy of the rescue tracing has to be kept in the managers office and other two may be kept in attendence room and telephone room where they can be easily found out.

Rescue tracing differs from ventilation plan in respect of showing reserve station on rescue tracing, other details are same on both rescue tracing and ventilation plan.

Q. What are the duties of Manager in an emergency ?

A. Duties of manager in an emergency :

1. On receiving information of any emergency, the manager shall immediately :

- Uniform rescue station or rescue room serving the mine.
- Summon rescue trained persons employed in the mine
- Inform the management of adjacent mines for rescue help
- Inform the management of rescue station regard ing the nature of emergency
- Summon medical assistance; and
- Send information to Regional Inspector of Mines.

2. All rescue and recovery work shall be conducted under the control, supervision and direction of the manager. However, in case of major emergency, the manager shall take guidance from an expert group consisting of senior official of management, representative from D.G.M.S., concerned rescue station and recognised trade unions in taking decisions regarding rescue and recovery.

Q. What is life-line ?

A. The life-line is generally a light-weight cotton or manila rope about 10m long, having springs hooks attached to both ends. It is used by rescue team during rescue and recovery operation if the atmosphere is obscure. This is led from fresh air base to the rescue operation site.

Q. What are the dangers and difficulties encountered by Rescue Teams in fire area ?

A. Following are the dangers and difficulties encountered by Rescue teams in fire area :-

1. Danger due to heat – They may not be able to stand or cross the fire.
2. Feeling thirsty
3. Because of smoke and dust, visibility will be hampered.
4. Irritation in eyes, if open.
5. Burning, if they walk in disguised fire area.

Q. What is difference between Breathing apparatus, Escape apparatus and filter apparatus ?

A. Breathing apparatus :

1. This is a closed circuit oxygen regenerating type of apparatus
2. It is used by rescue trained persons only.
3. This is for rescue and recovery work only.
4. It has got a limited period of operation of 2 hours.
   Ex – Protomark IV
   Drager BG - 174

Escape apparatus :

1. This is an apparatus for escaping from area having noxious and poisonous gases.
2. It may be used by untrained persons.
3. It is also closed circuit apparatus.
4. It has got a limited period of 45 minutes
5. It is used by person in danger to escape.
   Ex – Savox

Filter apparatus :

1. This is an apparatus which filters the poisonous gas(CO) from inhaling air.
2. This apparatus is used to escape oneself from poisonous atmosphere.
3. This is open ckt apparatus.
4. It has got a limited period of operation of 30 minutes & 95 minutes or 1 hour.
5. It can't guard another gases.
   Ex – MSA self rescuer.

Q. What is difference between Reviving apparatus, Resuscitation apparatus and tube apparatus ?

A. Reviving apparatus :

1. This apparatus is used for persons who can breathe and not going to die immediately.
2. This is oxygen type apparatus.
3. Limited period of use depends on the capacity of oxygen cylinder

Ex – Maxaman Novox

Resuscitation apparatus :

1. This apparatus is used for persons to bring back breathing who is almost dieing

Ex – pulmotor

Tube apparatos :

1. This is an apparatus to which air is supplied from a distance.
2. To rescue a person who is overcome by gas or other type of atmoshphere.
3. Limitation is that there shall be fresh air at some distance.
   Ex-smoke helmet.

Q. What is an ideal Rescue Team ?

A. An ideal rescue team consists of following :-

(a) Leader :- The leader may be manager or A.C.M or Sr. overman or surveyor.

The desirable quality of leader is :

(i) Good judgement ability
(ii). Organising capacity

(b) Member 1 :- Short firer, or mining sirdar or overman of affected or neighbouring district be cause they have good workability knowledge of area.
(c) Member 2 :- Asstt. Engineer or Electrician or Fitter for better engineering jobs.

(d) Member 3 :- Prop mistry for better and quick supporting jobs.

(e) Member 4 :- Mason for masonary works.

(f) Member 5 :- Prop mazdoor or stone cutter or Tyndal for easy doing of heavy jobs.

Coal Washing

Q. What is coal preparation ?

A. It is a collective term for any physical, physico-chemical or mechanical treatment accorded to run of mine coal with the sole purpose of making the whole coal or any of its products suited for any specific use. The processes may include hand cleaning, hard selection,mechanical picking or de-shaling, blending, breaking, crushing, pulverizing, screening, wet–washing, dry-cleaning, dedusting, dewatering, drying, floatation, agglomenation or even briquetting.

Q. What is coal washing ?

A. Coal washing forms a vital link between coal mining and coal marketing. Coal washing means increasing the commercial value of coal by suitable preparation, achieved generally through crushing, screening and gravity seperation often supplemented by other allied operations. The ash % in coal is reduced by coal washing.

The washability characteristics of coal is greatly influenced by the nature and degree of intermixing of coal and dirt. Indian coals have difficult washing characteristics owing to the intimate mixing of a fairly large part of the dirt or mineral matter in most of the coal seam.

Q. What are the ill-effects of excessive dirt in coal ?

A. Major production of coal are consumed usually for iron and steel making, steam raising and/or power generation. In such usage, the ill-effects of excessive dirt in coal are outlined as follows :-

(i) Dirt in excesss of specified limit affects the utilisation efficiency and load factor.

(ii) The useless transport of dirt along with coal and its subsequent disposal as cinder or slag also cost money and results in some loss of sensible heat.

(iii) In conventional iron and steel metallurgy, an increase in ash content of coke by 1% over a critical limit results in decrease in production by 3 to 6% and involves an increase in coke consumption by 4 to 5%.

(iv) For consumption of coal in steam locomotives, the ash penalty of each one unit of ash beyond a specified or derable limit often becomes quite excessive and leads to uneconomic operation.

(v) In thermal power generation by conventional technique excessive amount of ash in feed coal not only calls for additional capital investment and results in sensible heat loss with cinders but also causes frequent hazards in operation and maintaince, which affects the load factor immensely.

Q. What do you mean by washability of coal ? How the washability characteristics of coal is evaluated ?

A. The washability of coal generally mean amenability of a coal to improvement in quality by cleaning usually through gravity seperation processes. The normal procedure to assess the cleaning potentialities of a coal is to carry out float and sink tests in the laboratery on a representative sample of coal after crushing and screening it to desired size-limits.

For evaluation of washability characteristics of coal, the float and sink analysis is carried out in which the coal sample of any specific size-grade is fractionated into well-defined density levels by the use of organic-inorganic liquids of widely varying densities in suitable combinations. The float and sink results of these tests are represented in the form of curves known as washability curves. The four different kinds of standard washability curves, which give graphical representation of the relative density composition of

raw coal or any of its size-fractions with percent yield as one of the co-ordinates and percent ash or relative density as the other coordinates are listed below :-

(i) Characteristics curve / Fractional yield ash curve The curve derived from the fractional yields and ash% of the float and sink analysis of a coal showing directly at any yield of floats (or sinks), the ash content by those particles of the floats (or sinks), which are highest (or lowest) in ash.

(ii) Total floats - Ash curve/ Cumulative floats curve The curve obtained from the float and sink analysis (or from the characterists curve) representing the average ash content of the total or cumulative weights of floats at any particular relative density of cut.

(iii) Total sink - Ash curve/ cumulative sinks curve obtained from the float and sink analysis representing the average ash content of total cumulative weights of sinks at any particular relative density of cut.

(iv) Relative Density - yield curve- obtained from float and sink analysis by plotting cumulative weights of floats or sinks against the successive relative density of cut.

Q. What are the criteria for defining washability characterists of coals ?

A. While the washability curves gives some general impression regarding the cleaning possibilities of different coals, they fail to bring out a correct asessment by their comparative cleaning characterists because of the involvement of a no. of parameters including the ash content of the raw and clean coals, even if the relative density of seperation is maintained at the same level.

Hence, the following criteria have been evolved to define the ease or difficulty of the cleaning behavious of coal :-

- (i) Near gravity material (N.G.M)
- (ii) Yield reduction factor (Y.R.F.)
- (iii) Washability index (W.I.)
- (iv) Optimum degree of washability (O.D.M.)
- (v) Washability number (W.N.)

(i) Near gravity material :- It is defined as the percent yield of total coal, which remains distributed with ± 0.10 specific gravity range of the desired or effective density of seperation.

(ii) Yield reduction factor :- It is defined as the percent reduction in yield for each one percent reduction in ash content at any selected ash level of the clean coal.

In case of Indian coal

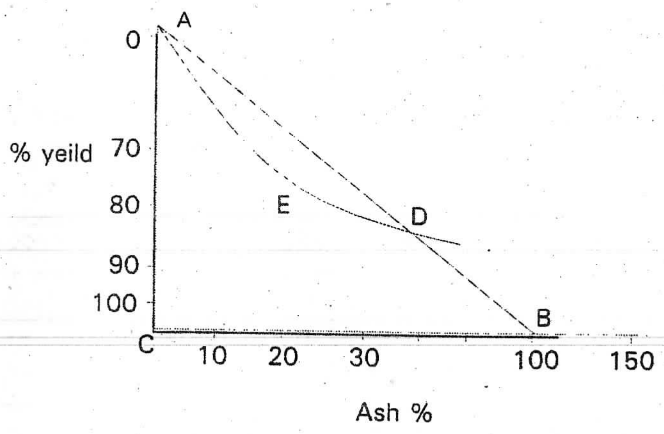
YRF	Washing character
<4	Medium washing
>4	Difficult washing
>6	Extremely difficult washing

(iii) Washability Index :-

It is expressed as the area bounded by the curve (yield %vs Ash %) and the diogonal through (zero yield and 100 % Ash) as percent of the total area bounded by the two axes and the diagonal .

$$\text{W.I.} = \frac{\text{Area AED}}{\text{Area ABC}} \times 100$$

When the index is low , the coal is dificult to wash and the index is high, the coal is easy to wash .



Washability Index	Washing Characteristics
> 60	very easy
41 -60	easy
31 - 40	Medium
21 - 30	Difficult
< 20	very dificult

For Jharia & other coal fields, W.I. = 15 - 43
For Assam & other coal fields, W.I. = 47 - 76
For British, German, American & Chilean coals, W.S= 45-76
For Japnese , Autstralian & South American coal,W.I = 20-49

(iv) Optimum degree of washability :- For every coal, there is an optimal cut point, where one can expect the maximum advantage in coal – dirt seperation.

While the Washability Index gives a general impression about the overall washability characteristics of coal,it fails to locate this optimal cut point.

Degree of Washability at any particular level of cut can be expressed as :-

$$\text{D.M.} = \frac{\text{Recovery \% of clean coal}}{\text{Ash \% in raw coal}} \times (\text{Ash \% in raw coal} - \text{Ash \% in clear coal})$$

By plotting the degree of washability against recovery % of clears at different specific gravity, a peak point is observed for each coal. The degree of washability corresponding to this peak point is designated as the Optimum degree of Washability.

(v) Washability Number :- To classify coals in accordance with their washibility characteristics, it is convenient to express the final value as the ratio of optimum degree of washability and clean coal ash at the optimum level.

Since in coals having extremely intractable cleaning characteristics the value of this ratio is often <1, a magnified scale is used by multiplying as the resultant value by 10 and rounding up the decimal (if any) to the nearest whole number. This magnified ratio is known as washability number.

Mathematically, it may be expressed as :

$$\text{W.N.} = \frac{\text{O.W.D.} \times 10}{\text{clean coal ash}}$$

For Indian coals in Jharia coal field,
W. N. = 12 - 30, For XI and above seams
= 10, For X and below seams

EXPLAIN WHY

Q. The reliance capel is so designed that there is always a gap between the wedge blocks.

A. The gap indicates the slipping of rope inside the capel, which is dangerous.

Q. Fleet angle is limited to 1.5°.

A. This is to avoid turning moment developed in head frame pulley and drum which may cause damage to bearings, as well as to avoid excessive friction under pressure against flange of the pulley causing wear and tear of rope.

Q. Outlets from a mine are not provided closer than 13.5m.

A.This is for the following reasons.
i) For ensuring stability of outlets
ii) For avoiding recirculation of air if one is intake and the other is return.
iii) In case of disaster interaction does no take place.

Q. The deteching bell or plate used in connection with safety hook is examined once in a month and opening therein is checked by calipers or gauze?

A. The entire operation of the safety hook depends upon the operation of the four plates in it and their exact dimension. If dimension are wrong, the performance will be very bad. Hence this should be opened every month and checked by calipers.

Q. Brick lining of shafts is built in segments with besetted foundations below each segment.

A.The load of the break lining is distributed segment wise. This load comes on its upper foundations. This is not transmitted to the lower one. Thus crushing or lining failure does not occur. Moreover the process can be continued at the time of sinking.

Q. Silt is regularly removed from the pit bottom sump.

A. If clearing is not regularly done, the silt may touched the cheese weight of the guide rope to make it slack which make cause collision of cages.

Q. High static factor of safety (at least 10) has been recommended for winding rope in case of man winding?

A. This is to compensate for dynamic load, bending stress, kinetic shock and loss in strength during service etc.

Q. The outer rail of the haulage track is superelevated at curves.

A. At curves, centrifugal force is generated to balance the centripetal force provided by friction between rail and tub wheels. The centrifugal force tries to turn the tubes on the outer sides. To balance this, a turning moment is created on opposite side by superelevating the outer rails.

Q. The trailing end of drag used behind ascending train of tubs is forked liked a fish tail.

A. The fish-tail helps the drag to be fastened in sleepers of the track in case of runaway of coal tubs.

Q. The melting point of a fusible plug of a fluid coupling is less than the flash point of the oil used.

A. The fusible plug melts before flash point of the oil is reached and allows the oil to drained down automatically and cool. So that the explosion of the oil can be prevented.

Q. The width of a man hole is not less than 0.75m but not more than 1m.

A. The width of manhole is not less than 0.75m but not more than 1m so that a man can enter smoothly for shelter but the tubs or any other rolling objects cannot enter into it.

Q. Soda acid type fire extinguisher or water is not permissible for fighting oil or electrical fire.

A. In case of electrical fire, electrocution is possible because both soda acid and water are good conductors of electricity. On the other hand, in case of oil fire, oil is lighter than soda acid and water both, hence oil comes up and fire does not extinguish.

Q. Fire is fought from the intake side.

A. While fighting fire, there are smoke, dust, fumes, CO, CO_2 etc on the return side which are dangerous to fire fighters, whereas intake side is free from these. Hence fire is fought from the intake side.

Q. Heavy type stone dust barriers are located farther from the face than the light type stone dust barriers.

A. The explosion pressure increases in its magnitude gradually as it travels away from its origin. Light type stone barriers may be toppled by less explosion pressure but heavy type barrier requires higher pressure to toppel.

Q. Water seals are provided in the isolation stoppings around rise goaf.

A. This is to allow the water from the sealed goaf to come out but the air is not allowed to enter the sealed goaf.

Q. For effecting explosion proof stopping two 1m thick brick stoppings spaced 4.5m apart with the intervening space filled with loose incombustible material are preferred to a 2m thick stoppings.

A. This type of construction has got shock absorbing power because of filling of incombustible material as compared to 2m thick stopping.

Q. It is not desirable to collect air samples from behind the stoppings when barometric pressure is rising.

A. At the time of rising barometric pressure the gas inside the sealed off area is pushed further inside. Hence, samples taken at this time will not be representative. Therefore, the air samples should be taken at the time of falling barometric pressure.

Q. While sealing a fire area in a gassy seam, the stoppings on the intake and return side are closed simultaneously at the end.

A. If any of these stoppings (intake or return) is closed the ventilation system of district stops. Hence they have to be stopped in such a manner that at least some air flown up to the last brick. As soon as the last brick is put, the persons should immediately be withdrawn.

Q. More than one auxiliary fan are not used normally in one ventilating district.

A.This is because chances of recirculation of air increases with use of more auxiliary fan in a ventilating district.

No. of fan	Possibility of recirculation
1	2 P
2	4 P
3	8 P
....	....
n	2^nP

Q. Use of interval combustion engine is not permitted below ground without permission of R.I.M.

A. This is to avoid the following hazards :-

(i) source of heat and hot surface
(ii) formation of CO and NO_2 in exhaust gas
(iii) Storage of fuel below ground.

Q. Intake side of partitioning brattice is wider than its return side.

A. The smoke, dust and fumes from the face is pushed to the narrow return side where from they are cleared quickly because of higher velocity. Moreover, the intake side remains clearer where persons move safely.

Q. Lime is sprinkled in the depressions where there is accumulation of black-damp.

A. Quick lime absorbs CO_2 to form $CaCO_3$. Hence the black damp is automatically removed.

$$\underset{\text{Quicklime}}{\text{Cao} + CO_2} - \underset{\text{Dead lime}}{CaCO_3}$$

Q. Cage with bird is carried at the end of a pole while checking for CO but a flame safety lamp is not carried in this manner while testing for black-damp.

A. The reaction of the CO on bird is dynamic i.e. it flaps its wings and falls of the perch, such activities can be seen from a distance . The reaction of CO_2 / black damp on flame safety lamp is to extinguish the flame silently. This cannot be seen from a distance.

Q. For ventilating a very long heading, a combination of in bye auxiliary fan of forcing type and out bye fan of suction type to push and pull the air is used.

A. If only forcing fan is used, the face will be ventilated but the smoke, dust and fumes will take a long time to clear because of the long heading. To avoid this situation, a suction or pull type auxiliary fan is also used.

Q. When two auxiliary fans of forcing type in the same ventilation ducting are used in series, the ducting immediately up stream of the in bye fan is punched circumferentially with holes and provided with a sleeve having coincident nozzles circumferentially.

A. At the time of sequential starting, the out bye fan is started first. At this time, the circumferential holes are kept open. This helps in efficient starting of fan and the air coming out through the holes will ventilate the area of the next fan for safe starting. After the second fan starts, the holes are closed to prevent recirculation of return air.

Q. The water gauge of a booster fan in a district is less than the difference in the ventilating pressures at the junctions of the intake and return road of the district with the corresponding main airways.

A. The water gauge of the booster fan should be less than the difference between ventilating pressures at main intake and return of the district. If it is not so, the return pressure out bye of the booster fan will be more than intake pressure in the region. This will cause leakage in reverse direction (i.e. from return to intake) and will result in recirculation which is dangerous.

Q. The more the water gauge of a booster fan in the district return, it has to be nearer of the junction of the district return.

A.This is done to prevent crossing of return pressure gradient to intake pressure gradient for prevention of recirculation. The more the water gauge of booster fan, it has to shift towards the junction of the district return for prevention of such recirculation.

Q. Multi-storeyed buildings are more sensitive to blast vibrations than single storeyed buildings.

A. When the ground virates, the lower part of the structure moves with the ground where as uperpart lags behind, resulting in differential movements in the structure components. Hence multi-storeyed buildings are more prone to structural damage.

Q. Why different types of explosives are not charged normally in the same shot-hole ?

A. The different types of explosives arenot charged in the same shot-hole because they have got different firing characteristics which interact and may cause blown outshots or misfire.

Q. Electric detonators of different resistances are not used in the same round of blast. Why?

A. Detonators of different resistances in the same circuit will create current imbalance causing misfire in some cases.

Q. Water spraying is done in a Coal face both before and after blasting. Why ?

A. Pre blasting spraying is done to suppress the dust in and around the face and post blasting spraying is done to suppress the dust, fumes and smoke generated by the blasting.

Q. Approved type of circuit tester is to be used for checking continuity before blasting a round of shot hole ?

A. This is to ensure that minimum amount of electric current passes through the circuit during testing. Otherwise, there may be premature blast.

Q. Inverse initiation is done in solid blasting. Why ?

A. This is done to avoid the possibility of blow out shots which is more likely in case of solid blasting.

Q. Why maximum duration of current in an approved exloder is 4 milli second ?

A. This is to avoid any chance of explosion of gas coming out from the face.

Q. Aluminium tube detonators are not permissible for use in u/g coal mines. Why ?

A. This is due to following reasons :-

1. Aluminium itself is exlosive in nature. Powder aluminium is highly explosive. Thus use of aluminium detonators, results in use of different types of explosives in the same shot-hole. The blasting characteristics will be different. Hence, chance of misfire or blown out shots may be more.

2. Aluminium burns with deflagration (i.e spreading hot particles all around). This may cause explosion of methane or coal dust.

Q. A Clay plug is inserted at the back of a sot-hole. Why ?

A. Since a crack detector cannot detect any crack at the back of the hole, it is necessary to insert a clay cartridge at the back of the hole. This Seals the crack. and explosion of gas is prevented at the time of blasting.

Q. It is not permissible to exceed the prescribed time interval of 60 milli-seconds between the consecutive shots, in solid blasting . Why ?

A. The time interval shall not be more than 60 milli-soconds because the gas liberatedd by the blasting of previous delay may be ignited by the current of the next delay.

Q. Formation of 'V' line of extraction isavoided while depillaring. Why ?

A. At the 'V' point, there is a combined effect of front abutent pressure on both the lines of extraction. However, 'V' point is not a square whcih is not capable of taking much load. Hence, 'V' point is avoided.

Q. Support at the goaf edge is made the strongest. Why ?

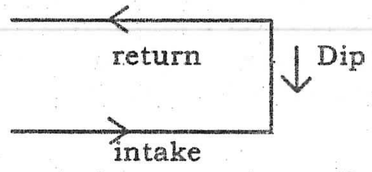
A. This is to break the roof at the goaf edge otherwise, the roof will sag instead of breaking.

Q. A slip or fault plane is supported on both sides of it. Why ?

A. This is because, the slip or fault plane is a plane of discontinuity and support is needed on both the sides otherwise one side will be supported and the other side will fall.

Q. In a L/W face, the bottom gate road is the intake airway whereas the top gateroad is the return airway. Why ?

A.



This is because, the natural ventilation pressure (NVP) will help the mechanical ventilatio system to make better ventilation.

Q. Depillaring operation is normally comenced from the major fault or dyke and it progresses away from them. Why ?

A. Fault or dyke is a plane of discon tinuity. If extraction is commenced from the fault or dyke side, the roof fall takes place smoothly. It starts from the otherside, there is a danger of massive premature collapse.

Q. A layer of coal is left against the shale roof which does not stand well. Why ?

A. This coal layer supports the weak shale. Moreover it does not allow weathering of this shale roof to make it further weak.

Q. Galleries are sometimes staggered Why ?

A. This is to minimise the roof exposure at a place where chance of roof fall may be more. This is the practice in case of weak roof. In case of steep seam, staggering is done to avoid roling of objects beyond limits.

Q. A prop is sometimes left undisturbed in the goaf if the roof does not come down warning. Why ?

A. Such props give indication of roof presure by bending even fracturing of lid and bulking of the prop. This helps in withdrawl of persons for safety.

Q. Props are set with an angle of underset of 2° for every 6° inclination of the seam from horizontal. Why ?

A. There is a relative movement of roof which is more unstable as compared to floor. Hence, if the prop is put normal to the seam, it will become loose. If the prop is put on vertical direction, it will become unstable on floor end: To make the prop adequately stable, it has been found that a position in between the normal and the vertical is better. Morever, it has been forund undersetting of 1° for every 6° inclination of seam is the best.

Q. Splitting of pillars shall not be done more than two pillars ahead of the pillar being extracted and at the commencement of depillaring not more than four pillars shall be splitted. Why ?

A. This is done to reduce the zone of stress concentration for ensuring stability of the workings.

Q. During depillaring diagonal line of extraction is maintained. Why ?

A. In such case, pressure is distributed along a long distance. It provides protection as the working places are supported by solid pillars and also when the roof caves, there is less risk of goaf flushing into the working faces.

Q. Copies of plans and sections shall be submitted to chief Inspector of Mines on or before 31 st october of every year by mine management, why ?

A. This is statutorily required because of the following reasons :-

(i) To know the annual coal production.
(ii) To know whether royalty given or not to Govt.
(iii)If AMPs not submitted, it can be used as a substitute of AMPs .
(iv)If Annual plan is to be submitted, then manager gets chance to bring the plan up-to-date atleast once in a year.

Q. Why fire is fought from the intake side ?

A. Carbon monoxide, smoke and other noxious gases are found due to fire which flow along the return side and so it is fought from the intake side which is free from these noxious gases.

Q. Liquid Nitrogen is not used to combat pillar fire why?

A. Liquid N_2 is not used to combat pillar fires due to thermal cracking of coal .

Q. Why inert gas is used for combating fire ?

A. Inert gases lower the reaction rate by lowering the concentration of the combustible and the oxidiser , absorb heat due to their own heat capaciry and narrow the flammability range

Q. Why liquid N2 is preferred to CO_2 in combating fire ?

A. Liquid N_2 is preferred to co_2 because it is available in plentiful quantity , easy to deliver through bareholes and it has better cooling effect.

Co_2 sufers from the defects of likelihood of absorption in strata, reduction to carbon monoxide while passing over heated coal and its tendency to migrate towards dip workings and once filled, they are difficult to flushout.

Q. Why coal - dust explosion is more dangerous than firedamp explosion ?

A. Lingering of flame occurs in coal dust explosions and there is burning effect which causes a series of explosions. Therefore, dangers of coal dust explosions is more than gas explosions as the gas explosion finishes as the gas is finished.

Q. Fire damp explosion is most violent when CH_4 content in air is 9.5 % by volume ?

A. When methane content in air is one eleventh i.e 9.5 % by volume, complete conversion of CH_4 to CO_2 and H_20 occurs.

$$CH_4 + 2 (O_2 + 4N_2) = CO_2 + 2H_2O + 8N_2$$

The above reaction is a self - accelerated reaction leading to an explosion.

When CH4 % in air is more than 9.5, O2 present will not be sufficient for its complete combustion and when it is less than 9.5 , O2 or atmospheric air will be in excess.

Q. What are the advantages of using two small auxiliary fans in series in case of a long drivage ?

A. When two small auxiliary fans are used in series, the water gauge is distributed and the difference in pressure between the inside and outside of the duct is high and consequently air leakage is reduced.

Q. The quantity of air hadled by the fan should not be more than one third of the quantity passing in the airway where fan is situated, Why ?

A. This is due to chances of re-circulation of air and in certain cases, the air current in the airway may be reversed.

Q. Why forcing fan is used during shaft-sinking?

A. A forcing fan is used during shaft-sinking because

i) it delivers swift current of cool and fresh air at the

shaft bottom.
ii) it clears away blasting fumes more rapidly from the immediate vicinity of the shaft-bottom and work can be re-started after shot firing.

Q. Why forced ventilation is recommended in seams liable to spontaneous heating ?

A. In seams liable to spontaneous heating, when the cracks caused by caving reach the surface, forced ventilation is recommended because the products of combustion from the coal are removed from the goaf to the surface and do not contaminate the mine air.

Q. In fiery seam or gassy seam of II and III degree, then are provision for providing two intake airways in a ventilating district, Why?

A. In a ventilating district of fiery or highly gassy seam, two intake airways are provided because it :-

(a) reduces effective resistance of the intake
(b) provides travelling way separate from the haulage-way and
(c) maintains sufficient ventilation if one intake is blocked by roof fall etc.

Q. Why a mine is divided into no. of districts or splits ?

A. Spliting of a mine reduces overall resistance of the mine and the fan capacity. It also reduces air velocity by distributing the quantitiy (Q=A.V) Explosions/ fires can be confined to one district only.

Q. Why main mechanical ventilator is installed on the surface at a distance of not less than 10m from the shaft opening or incline mouth ?

A. MMV is installed on the surface at a distance more than 10m from the mine opening because of the following :-

(i) To prevent MMV from the violence of explosion.
(ii) To be available for operation and approach in case of an emergency.
(iii) To prevent MMV from coming in the direction of outlets.

Q. Why a pressure recording instrument is provided in MMV. ?

A. This will indicate any substantial Variation in pressure. Low pressure indicates that doors are kept open or shaft covers are open. high pressure indicates that air may be chocked due to roof falls etc.

Q. Dewatering of inundated working is done at a slow rate if air is suspected to have been trapped due to sudden in rush of water why ?

A. If high rate of pumping is adopted, the layer seperating the air gap becomes thinner all on a sudden. The pressure of air bursts the layer causing water blast. If slow rate of pumping is adopted, the air bubbles come out releasing the air presure. Hence water blast cannot occur.

Q. During development of watery non-gassy seam drivage of level and rise gallaries are preferred but in a gassy seam drivage of level and dip gallaries are preffered ?

A. In case of watery non-gassy seam, there is no problem in rise driving as gas is not there and water will automatically drain down. But in case of gassy seam, rise driving cannot driven because there will be accumulation of gas and chances of explosion.

Q. Why a rib of coal is left against goaf ?

A. A rib of coal is left against goaf to prevent flushing of the waste in the working area.

The thickness of the rib is decided on the basis of the roof height and strength of coal so that it only stand just like a screen.

Explosive and Blasting

Q. What are the advantages of Solid Blasting over cut face blasting?

A. Advantages are

i) The technique of blasting off the solid is simpler, more economical and less hazardous than the conventional method of breaking coal with machine cutting and blasting.

ii) It can be used in steeply inclined seams and workings which are otherwise in accessible to CCM^{S}.

iii) It can be used in any condition - gradient, uneven floor condition or thickness of seam are not the constraints for it.

iv) Time required for one round is much less than pre-cut blasing, so number of rounds can be increased in a particular face in a shift resulting in more coal production.

v) In blasting coal off the solid, coal cutting machine is eliminated as the second "Free face" is provided by firing a few holes and than blasting the remaining holes into this opening. Both these operations are combined in one round by the used of delay detonators.

Q. Define the term "Stab hole" in solid blasting.

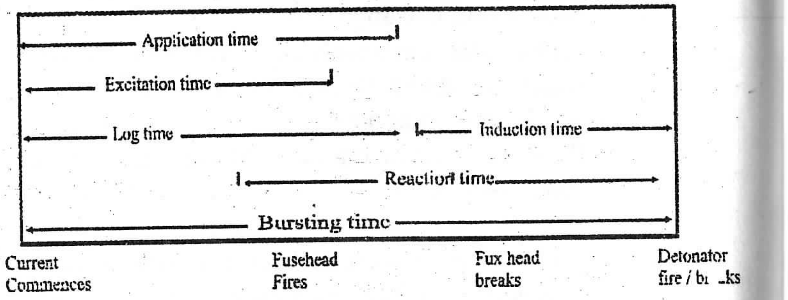
A. In solid blasting using wedge cut pattern of shot holes, two or more holes are drilled at an angle of less than 45^{0} so as to converge at the rear by keeping a gap of less than 0.3 mtrs. This arrangement provided a concentration of charge at the back and when these holes are fired with the same delay number, a wedge shaped opening is formed. With this pattern, the advance is limited and for deeper pull, burden should be reduced by providing a steeply inclined shorter hole at the centre. This central hole is known as "Stab hole".

Q. Discuss various sequence of events in firing electric detonators.

A. Various Sequence of events in firing electric detonators are

i) Commencement of electric current
ii) Firing of fuse head.
iii) Breaking of fuse head
iv) Firing/ breaking of detonators

The following chart gives the time required during the various sequence of events in firing



Busting time :- Time between application of current and bursting (explosion of detonator)

Reaction time :- Time between ignition of fuse head and bursting of detonator

Induction time :- Time between rupturing of bridgewire and bursting of detonator

Log Time :- Time between starting the applition of current and ignition of fuse head of detonators with or without rupturing of bridgewire. In extreme cases, it may be equal to excitation time. In certain cases it may be equivalent to bursting time.

Excitation time - Time between application of current and ignition of fuse head

Application time - Time between application of current and rupturing of fuse wire.

Exploders are designed to generate a peak current for a definite interval of time. Application time of exploder exceeds the exlitation time fuse head.

Q. What is "NONEL" ? What are the features and benefits of NONEL ?

A. Nonel is a non-electric initiating device which combines the versatality and advantages of electric delay detonators, detonating cord and also overcomes some of their limitations. It can be used for surface blasting, quarrying, trenching, large hole stoping, ring hole blasting and other underground blasting operations but in gassy coal mines.

It consists of a plastic tube with a very small quantity of reactive material in its annular space. A delay detonator is factory assembled at one end of the tube. The other end is sealed to prevent ingress of moisture and other foreign matter. Upon initiation, a low order shock wave travels through the tube and reliably initiates the detonator. The tube has no blasting effect on surrounding material and therefore acts merely as a singal transmission line.

Features :-

i) True bottom hole initiation.
ii) No pressure de-sensitisation of explosives.
iii) No damage to booster- sensitive explosive column.
iv) No stemming ejection. Leading to Premature venting of explosive energy.
v) Minimized noise and gas-venting through stemming.
vi) Multiple sequential delay intervals possible
vii) Reduced ground vibration levels through a reduction of maximum charge per delay.
viii) Improved overall rock breakage and toe removal.
ix) Reduced flyrock and air blast noise generation because of non-cratering effect.
x) Muckpile looseness and displacement.
xi) Less probability of mis-fire due to ground movement cut - off of detonating cord.
xii) Being non-electric, they are immune to extrneous electricity sources. Such as stray, currents, static electricity and radio frequencies emanating from Walkie-Talkies.

Benefits :-

- i) Maximum energy transfer from explosive to rock.
- ii) No energy loss - more energy yield per unit cost.
- iii) Less wastage, better utilisation of explosive energy
- iv) Environment friendly ; reduced energy loss
- v) Enhanced safety ; reduced premature detonation
- vi) Ultimate safely ; user friendly.

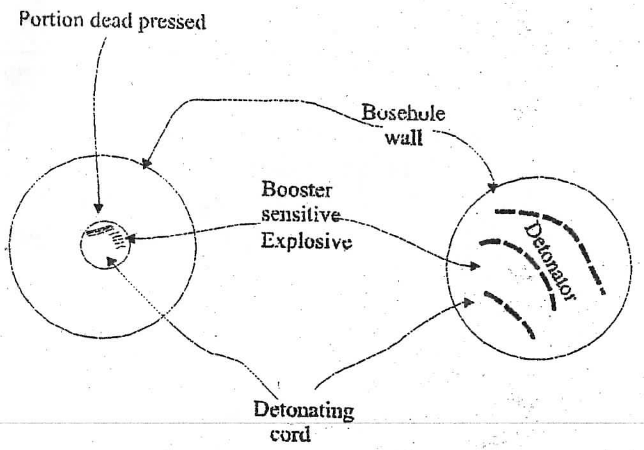
Q. What are undesirable affects while using detonating cord as downlines and trunklines in blasting process ?

A. Detonating cord having an explosive core of PETN detonates at a velocity between 6500-6800 m/s and generates lot of shock (brisance) and gas. Commercially available detonating cords contain 10 gms of PETN per metre length of cord, which has the initiating capacity of a detonator all along its length. They reliably initiate cap-sensitive cartridged explosives as well as cast boosters. Detonating cord having a core load of 6 gm / metre also initiates cap- sensitive cartridged explosives but normally does not reliably initiate conventional cast boosters unless the boosters are designed suitably. Use of detonating cord as downlines and trunclines cause several undesirable effects both in the desired blasting process as well as in the explosive performance. They are -

- a) They cause partial desensitisation of booster- sensitive explosive in the bore hole.
- b) Side- initiation of explosive by the detonating cord downline.
- c) Ejection of stemming material
- d) Multi- point initiation of borehole.
- e) Probability of mis-fire due to ground movement cut.off of detonating cord.
- f) Cratering effects leading to airblast noise and fly rock.
- g) Generation of air blast noise when used as surface trunkline

Q. Discuss the term "Desensitisation of Explosive."

A. While detonating cards initiate cap-sensitive explosives, they are known to cause partial desensitisation of booster-sensitive explosives in the bolehole. Explosive in the immediate vicinity of the detonating cord downline gets disturbed or destroyed resulting in some quantity of the explosive becoming in effective to detonate, which is known as desensitisation of explosive.



Dead Pressing caused by Detonating Cord

Research studies have shown that ANFO, under the action of detonating cord, gets dead pressed and at times becomes rock hard,rendering that portion useless. Similarly, slurry and emulsion explosives sensitised by air/gas bubbles or micro ballons also get affected by this action of detonating cord resulting in reduced energy output. The effect is more pronounced in explosives sensitised by micro-ballons since they tend to break by the shock wave, whereas air/gas bubbles get compressed but regain their original state after passage of the shock wave. However, some damage to both slurry or emulsion matrix does take place in the immediate vicinity of the cord. Moreover, the extent of desensitisation effect gets reduced with increase in borehole diameter.

Q. What is cratering effects ?

A. Since detonation starts at the top of the drillhole, the first cap sensitive cartridge in contact with this detonating cord would detonate first. This would result in cratering and the effect would be more pronounced if the burden at that point is higher than the depth of burial of the cap-sensitive cartridge. The explosive energy would take the path of least resistance and hence crater upwards with lot us violence resulting in flyrock, airblast noise.

Q. Discuss the consequences of poor blasting.

A. In a given geological condition, the degree of fragmentation is the result of energy input and its destruction in the rock mass. The fragmentation can then be controlled by adjusting this powder factor or by drilling pattern or by adjusting the combination of both.

A particular drilling and blasting pattern will result in a degree of fragmentation which will subsequently influence the productivity and costs of subsequent operations like loading, hauling, crushing etc. Hence for desired results. Proper blasting should be done. Improper and poor blasting leads to following consequences:-

i) Increase in Secondary drilling and blasting.
ii) Low excavator efficiency due to frequent holdups due to boulders, high loading time, low fill factor etc.
iii) Low dumper productivity due to excess waiting time and fill factor.
iv) High maintenance costs of excavators and dumpers.
v) Boulders cause frequent crusher holdups and results in poor crusher productivity.
vi) The flyrock, ground vibrations and air blast generated by bad blasts may cause injury/ damage to men/ material. Such incidents often lead to severe legal and law & order problems resulting in extra costs.
vii) The back break, overbreak and back throw produced by a bad blast makes subsequent drilling very difficult and requires doing and levelling.
viii) The poor blasting practices also result in unstable pit slopes and requires shallow slope angles resulting in extra over burden removal. This problem becomes severe as the pit becomes deeper and larger.

Q. What are the environmental impacts of blasting operations ?

A. Apart from the effective utilisation of explosives in fragmenting and displacing rockmass, a major proportion of energy is wasted in producing detrimental side effects like ground vibrations, air blast, flyrocks, dust and fumes, endangering the ecology and structural stability in the neighbouring areas.

The environmental impacts of the blasting operations are therefore, increasing due to the increased use of explosives. Ineffective blasts may result in the following damages :-

- Effect on vegetation.
- Failure of slopes.
- Overbreak and back break [illegible] exclavations.
- Stability problems to residential and other structures.
- Damage to health and hygiene in the surroundings.
- Migration of wild life
- Alteration in ground water flow patterns due to change in microcrack network system.

Compared to the other types of pollution, the effect from the blasting operations is perceived by the human beings more effectively. Assessment, prediction and control of these environmental effects, therefore, becoming increasingly important.

Q. Write short notes on
a) Electrical plasma blasting
b) Acconex
c) Cast blasting

A. a) Electrical plasma blasting :- Electrical plasma blasting technology is basically an electrical technique in which electrical energy transforms on electrolyte solution in a borehole into a high pressure high temperature plasma. Plasma is a fourth state of matter characterised by a collection of changed particles lions and electrons of low density).

The plasma produced in the hole expands faster than normal seismic wave propagation velocity and forms a shockwave. In time, the rock is shattered by the stress field produced by the shock wave without producing excessive dust and debris. Initially boulders of 4T- 5T size are produced which are further broken by a secondary breading machine which is mobile and autonomous. The production capacity of machine is soot/shift. The machine is developed by Noranda Technology Centre, Canada

b) Acconex :- Acconex is non-explosive silent demolition compound different from conventional materials/system like explosives/hydraulic splitter. It does not cause any noise, flying debris, toxic fumes, vibration or any environmental pollution.

Acconex functions by exerting expansive stress generated when the material is poured in the drilled holes in slurry form. The expansive stress reaches a level more than 6000 t/m^2 Normally the compressive stress of rock is in the range of 1000 to 2500 t/m^2 in concrete. The tensile fracture stress is very small which ranges from 40 to 50 kg/cm^2 in rock and 15 to 80 kg/cm^2 in concrete. Since demolition with Acconex is based on fractures due to tensile stress, all kinds of rock and concrete can be demolished by initiating cracks.

The propagation of cracks take place as follows -

- Crack initiation
- Crack propagation
- Crack widening

The fracture mechanism initiated through expansive stress produced by Acconex clearly indicates the development of cracks from inner surface of the hole due to tensile stress generated at right angles with compressive stress. The expansive stress also helps to propagate new cracks during the process. Though Acconex

expands in all directions, it does not spent out through the top if it is properly used as per directions specified due to strong frictional resistance to the surface of the holes.

c) Cast blasting or throw blasting is described as the controlled placement of overburden by drilling and blasting to achieve the optimum overburden removal cost.

The technique is suitable for use with large or small draglines and can be adapted for shovel and dragline operations in conjuction with track dozers to place upto 40% of the overburden in final position.

- The savings in cast blasting arise due to
- A percentage of overburden placed in final positions.
- Improved equipment productivity due to muckpile looseness and fragmentation.
- Additional mineral exposed by mining equipment as a result of a percentage of overburden in final position.
- Potentially reduced rehandling in dragline operations.
- Reduced capital investment.

Q. What are the factors influencing the production and productivity of SDL district in U/G mines ?

A. Such factors are

i) Pillar dimension : There is considerable reduction in production with lower Sizes of Pillar as Compared to larger pillar sizes keeping other parameters same.

ii) Face dimension : In Bord & Pillar workings face dimension plays an important role on overall production (Coal preparation time and yield of coal) of the mine. It also depends upon type of mechanization adopted at the coal face. Besides this, Pull, width hand height of faces are also equally important for the coal output per round of blast.

iii) Number of headings in the district : The number of headings determines the number of faces available in the district and therefore dictates the number of machines to be disployed and overall production of the mine.

iv) Multiple operating gangs for the face operations : This is required for desired level of production. Each gang of workers is assigned to do a specific work. Different gangs are systematically deployed at different working fronts to get the best productivity.

v) Mine operating system model : A generalised mine operating system has been considered for the purpose of model development to simulate the SDL based working in bord and pillar development district. There are smaller panel comprising of 2,3,4 number of headings and bigger panel comprising of 5&6 number of heading. Each heading (except top and bottom most headings) comprises of 3 faces namely dip, size and level. Besides SDL machine, hand held electric drill machines are there to prepare coal in the face.

vi) Available shift hours : Higher will be available shift hours, may will be the utilisation of SDL's and hence increased production and productivity.

vii) Lead distance : Higher is the lead distance, lower is the productivity of SDL. Increased Read distance reduces the number of frips by SDL in a shift and thereby reducing the overall production. For an increase of 25-30m in lead distance the tonnage handled by SDL reduces to an extent of about 6%

viii) Gradient : Gradient plays a vital role for SDL working. Hence optimum gradient is essential for smooth operation of SDL and desired result.

ix) Some other important factors are

- a) Work culture
- b) Operating Skills/training of the operators
- c) Standard of maintenance - backup services.
- d) Telecommunications
- e) Supervision
- f) Discipline

Q. What are the factors affecting the load bearing capacity of a timber ?

A. Factors affecting the load bearing capacity of timber can be examined as follows :

i) Length to diameter ratio of the prop : Higher is this ratio lower is the load bearing capacity of the prop.

ii) Eccentricity of the prop : Eccentricity is defined as the maximum deviation of the natural axis of the prop from its longitudinal axis expressed as a percentage of the lengths of the prop.

Higher is the eccentricity, lower is the load bearing capacity of the prop.

iii) Moisture content : In general, below the fibre saturation point, the strength of timber decreases with increasing moisture content. Any further increase moisture content beyond the fibre saturation point has practically no influence on the strength of timber. The moisture content of timber depends upon the atmospheric conditions in which the timber is kept or used and also on whether the timber has been seasoned or not and on the species of timber.

iv) Presence of defects : The nature and amount of defects greatly affect the strength properties of timber. Timber with defects like sap rot, hollows, cross breaks and large holes are not fit for use as supports in mines.